NPS54-85-08

NAVAL POSTGRADUATE SCHOOL

Monterey, California

AN ANALYSIS OF QUANTITY-SPLIT AND NONRECURRING COSTS UNDER COMPETITIVE PROCUREMENT ENVIRONMENT (Vol. 1)

by

Dan C. Boger

and

Shu S. Liao

September 1985

Prepared for:

Naval Air Systems Command, Washington, D. C. 20361

NAVAL POSTGRADUATE SCHOOL
Monterey, California

RADM. R. H. Shumaker
Superintendent

David A. Schrady
Provost

The research summarized herein was sponsored by Naval Air System Command, Cost Analysis Division under work order N0001985WR5279W.

This report was prepared by:

UNCLASSIFIED
Y CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

ORT SECURITY CLASSIFICATION classified	1b RESTRICTIVE MARKINGS
URITY CLASSIFICATION AUTHORITY LASSIFICATION / DOWNGRADING SCHEDULE	3 DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
ORMING ORGANIZATION REPORT NUMBER(S) S54-85-08	5 MONITORING ORGANIZATION REPORT NUMBER(S)
ME OF PERFORMING ORGANIZATION val Postgraduate School — 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION Naval Air Systems Command Cost Analysis Division
RESS (City, State, and ZIP Code) nterey, CA 93943	7b ADDRESS (City, State, and ZIP Code) Washington, DC 20361
ME OF FUNDING / SPONSORING ANIZATION val Air Systems Command — 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N0001985WR5279W
RESS (City, State, and ZIP Code) shington, DC	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

E (Include Security Classification)
Analysis of Quantity-Split and Nonrecurring Costs Under Competitive Procurement vironment (Unclassified)

SONAL AUTHOR(S)
n C. Boger and Shu S. Liao

PE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
nal Report	FROM JAN 85 TO SEP 85	30 September 1985	74

PLEMENTARY NOTATION

COSATI CODES		
LD	GROUP	SUB-GROUP

18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Cost estimation; NonRecurring costs; Dual Source Competition; Quantity-split; Dual award Quantity allocation

TRACT (Continue on reverse if necessary and identify by block number)

is study addresses two issues related to establishing a second source and managing a ogram under dual source competition. The first relates to the issue of estimating nrecurring costs and the second relates to the issue of dual award quantity-split. veral nonrecurring cost estimation models, both parametric and nonparametric, are amined. Five different quantity-split models are analyzed to evaluate each model's rength and weakness in cost performance and its ability to cope with contractor mesmanship.

RIBUTION / AVAILABILITY OF ABSTRACT CLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION
ME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) — 22c OFFICE SYMBOL

RM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

AN ANALYSIS OF QUANTITY-SPLIT AND NONRECURRING COSTS UNDER COMPETITIVE PROCUREMENT ENVIRONMENT

Volume 1

by

Dan C. Boger

and

Shu S. Liao

Department of Administrative Sciences

Naval Postgraduate School

Monterey, CA 93943

September 1985

PREFACE

This study was conducted for the Naval Air Systems Command, Cost Analysis Division (Air-524), under contract number N0001985WR5279W, dated 13 February 1985. The objective of the study is two-fold. The first is to address the issue of estimating nonrecurring costs associated with establishing a second source. The second is to examine the dual award quantity-split issue in order to minimize the effect of contractor gaming and maximize financial benefits to the government.

This final report, along with a companion volume, is submitted in fulfillment of the contractual requirement. The companion volume is not available for public release.

EXECUTIVE SUMMARY

This study addresses two important issues related to establishing a second source and managing a program under dual source competition. The first relates to the issue of estimating nonrecurring costs. The second relates to the issue of dual award quantity-split in order to maintain a competitive environment.

In dual sourcing decisions, it is necessary that the nature and extent of prospective second source's nonrecurring costs be fully analyzed. Nonrecurring costs are important since they represent those investment costs which must be incurred before the second source produces any output.

This study examines current estimating practices, presents several models, both parametric and nonparametric, of nonrecurring costs, and analyzes the key components of nonrecurring costs experienced by several programs.

Three general observations may be made from our analysis. First, there was an inconsistent treatment of cost elements as fixed or variable. This problem is especially crucial with respect to such items as initial and rate tooling, for example. This provides great difficulties for future analysis of the dual sourcing decision. Second, each analysis tends to have its own unique methods to aggregate costs into the cost elements used for analysis, thus making it impossible to utilize data compiled from prior study for analytical purpose. Third, a predominant methodology in estimating nonrecurring costs was to use an analogy approach for the second source costs by basing estimates

upon the nonrecurring costs experienced by the first source. Lacking any other methodology, this is clearly a reasonable approach. However, note that this constrains the finest level of disaggregation of the cost elements to that used by the first source in reporting nonrecurring costs on the initial contract, and this may not be an ideal or even reasonable cost element structure.

We conclude that, before a valid estimation model can be developed, it is imperative that fixed cost components be separated from variable cost components in the cost element structure. The lack of a usable database for nonrecurring cost estimation may also be attributed to the lack of standard cost element structure. Therefore, if there is to be any progress in modeling these nonrecurring costs, a reasonably standard cost element structure must be adopted to ensure compatibility of cost elements across systems.

A key issue facing the program manager in charge of a dual source program is the allocation of annual quantity requirements among the competing suppliers. The quantity split issue is crucial for two reasons. First, it affects the amount the Government pays for its weapon system requirement. Second, it affects the contractor's bidding strategy in its pursuit of profit to compensate the investment. Chapter 3 discusses the relationship of dual source quantity-split method and potential price gaming strategies. Three ways of price gaming are identified and actual step-ladder bid data from three major programs are analyzed to validate the hypothesis.

Five alternative quantity-split models are analyzed. For comparison purposes, these models are applied to two major programs. Actual step-ladder quotes for these programs are used to see what would have happened had these models been used for award decisions. From the standpoint of cost performance, the minimum total cost rule and the dual competitive award method seem to be more effective than the other three. However, only Pelzer's method and the dual competitive award method made a modest attempt to cope with the price gamesmanship. Therefore, we conclude that it is imperative that a new dual award quantity-split method be developed to cope with the contractor's price gaming.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

There is a clear preference in government procurement, especially defense procurement, for competitive awards. This policy is clearly reflected in current administration policies and Congressional pressure. It is believed that competition places the government in a more favorable position. However, in order to introduce competition in major weapons system procurement, a second source of supply must be created. This study addresses two important issues related to establishing a second source and managing a program under dual source competition.

ISSUES IN DUAL SOURCE COMPETITION

Since 1809, the position of the Federal Government has been to procure, to the greatest possible extent, goods or services on a competitive basis. This position has been reaffirmed both by the current Administration and by Congress. However, the recent push for competitive procurement finds its roots in the pursuit of financial savings.[1] Three major factors must be considered in evaluating the desirability of developing a second supply source and the feasibility of realizing financial savings from weapon system competition.

Potential Savings from Unit Price Reduction

One of the major reason for using competitive procurement is the savings potentially available from unit price reduction.

---

[1] Public Law 98-369, effective April 1, 1985.

Conventional wisdom suggests that the unit price of products will drop when price competition is introduced. Therefore, the effect of introducing competition to a procurement program on weapon system prices has been the focus of numerous studies in recent years.

Nonrecurring Costs

Nonrecurring costs are unavoidable when a contractor is to be qualified or when a change in configuration is necessary. The cost to establish a competitive second supply source can be high and difficult to estimate. The process of analyzing the implications of the current drive to procure most weapon systems on a competitive basis is analogous to forecasting the future cost and benefits derivable from any other investment. The present value of future savings from price reduction must be netted out against these front-end nonrecurring costs in determining whether competitive bidding should be used.

Optimal Quantity Split

The problem of quantity-split is present in every program that has dual sources. On the one hand, there is the minimum sustaining quantity to consider. On the other hand, there is a host of gaming strategies that can be played by both contractors. Fixing the quantity-split, say at 70/30, would simply open the door for gaming. Varying the split ratio according to bid prices reduces the chances for gaming, but an effective method for optimal quantity management is needed in order to take advantage of the competitive environment.

STUDY OBJECTIVES AND APPROACH

The economic consequence of weapon system competition has been the focus of numerous studies in recent years. Much of the focus, however, has been on the potential reduction in price. Little attention has been directed to the issue of second source start-up cost and the method of optimal quantity split when two suppliers are established.

Objectives

The first objective of the study is to explore the methods of nonrecurring cost estimation when a second source supplier is to be established.

The second objective is to evaluate alternative methods of dual award quantity split, examine the gaming strategies utilized by contractors in bid pricing, and determine the optimal method for annual quantity allocation between two suppliers.

Approaches

Due to the lack of prior studies, a logical strategy to address the issue of nonrecurring cost estimation is to examine current estimating methods utilized by analysts to assess the appropriateness of each practice and, hopefully, shed some light on a feasible and systematic way of estimating nonrecurring costs. Interviews with cost analysts of all three services of DoD and major contractors were conducted to establish and analyze different practices.

Since the decision on quantity-split must necessarily depend on the bid price, understanding contractor's pricing strategy is essential in the quantity-split decisions. Data of annual step-ladder bids for two major weapon systems were analyzed for pricing strategies. Five different quantity models used by, or proposed for, all three services were examined and tested with the step-ladder bids data. The results offer a unique opportunity for evaluating the strength and weakness of each model.

Since the bid data used in this study are competition sensitive, the identity of relevant parties and bid prices were masked in this report. Actual data are included in Volume II of this report.[2]

---

[2] Not available for public release.

CHAPTER 2

ESTIMATING NONRECURRING COSTS

In dual sourcing decisions, it is necessary that the nature and extent of nonrecurring costs be fully analyzed. Nonrecurring costs are important since they represent those investment costs which must be incurred before the second source produces any output. It should be noted that the only way dual sourcing will produce overall cost savings is for the present value of the eventual recurring cost savings to offset the present value of the nonrecurring investment costs. Hence, good measurement and models of nonrecurring costs are required in order to determine whether dual sourcing can save costs.

It cannot be overemphasized that, from the start, acquisition strategy is an important element in the dual sourcing decision. Not only can the strategy generate effective plans for dual sourcing, but different dual sourcing strategies can create large differences in the nonrecurring costs incurred under dual sourcing.

This chapter will examine current estimation practices, present several models, both parametric and nonparametric, of nonrecurring costs, and analyze the key components of nonrecurring costs experienced by several programs. Conclusions and recommendations concerning nonrecurring costs in dual sourcing will be presented in Chapter 5.

CURRENT ESTIMATION PRACTICES

In an attempt to learn what methods are actually being employed to estimate nonrecurring costs of competition, a survey of various activities involved in such estimation was undertaken. Procurement activities of all three services, as well as contractor sources, were queried. Upon examination of the estimation methodologies and results gained from the survey, the following points were observed.

There was an inconsistent treatment of cost elements as fixed or variable. This problem is especially crucial with respect to such items as initial and rate tooling, for example. Initial tooling is clearly a nonrecurring cost but rate tooling is a variable cost; despite the clearness of this observation, most studies lumped initial with rate tooling and called the combination a nonrecurring cost. This provides great difficulties for future analysis of the dual sourcing decision. Because the second source will not be required to incur all of the production start-up costs of the first source, the premise of this estimation exercise requires the ability to discern the nonrecurring from the recurring costs.

Another observation from the survey is that each study used a unique method to aggregate costs into the cost elements used for analysis. In some cases, such obvious costs as project management were not broken out separately but were lumped into other categories.

The final observation is that a predominant methodology in estimating nonrecurring costs was to use an analogy approach for the second source costs by basing estimates upon the nonrecurring costs experienced by the first source. Lacking any other methodology, this is clearly a reasonable approach. However, note that this constrains the finest level of disaggregation of the cost elements to that used by the first source in reporting nonrecurring costs on the initial contract, and this may not be an ideal or even reasonable cost element structure.

MODELS OF NONRECURRING COSTS

Several publicly-available analyses from the survey presented enough information on their construction to warrant in-depth examination. These were analyses of the potential effects of dual source competition on the procurement of the Advanced Intercept Air-to-Air Missile (AIAAM) and the Multiple Launch Rocket System (MLRS).

AIAAM Analysis

A report considering the cost implications of establishing a second production source and implementing dual source competition for the AIAAM was prepared by Science Applications, Inc. (SAI).[3] The SAI report was based upon a classified report prepared by Naval Weapons Center, China Lake.[4] The NWC cost estimates, based upon an extensive database of current missiles (Phoenix AIM-54A, Sparrow AIM-7F, Sidewinder AIM-9L, HARM, Harpoon, Condor, SUBROC, and Maverick), were modified by SAI. These modifications affected the learning curve slopes (SAI assumed a more complex learning effect with a steeper learning rate) and the nonrecurring production

---

[3] M. N. Beltramo and D. W. Jordan, "Analysis of the Cost Implications of Dual Source Competition for the AIAAM," Division of Cost Analysis (MAT-01F4), Headquarters, Naval Material Command, 2 March 1983.

[4] "Advanced Intercept Air-to-Air Missile (AIAAM) Life Cycle Cost Estimates" (U), Naval Weapons Center, China Lake (Code 081), NWC TM 4899, September 1982 (C).

costs (these were not broken out separately in the NWC report but were allocated on a sublevel basis in the SAI report).

The SAI report contains several parametric models of procurement support costs which include nonrecurring and recurring costs. The models were fitted to NWC estimates at 6,000, 8,000, and 10,000 units. With Q representing cumulative quantity and costs measured in FY83$K, the models are shown in Table 2.1.

Table 2.1

AIAAM Models of Procurement Support Costs

System Engineering/Project Management	
Contractor	Total Cost = $41100\ Q^{.172}$
Government	Total Cost = $14300\ Q^{.172}$
Tooling/Test Equipment	
Contractor	Total Cost = $1300\ Q^{.444}$
Government	Total Cost = $900\ Q^{.158}$
Test and Evaluation (Government)	Total Cost = $11000\ Q^{.169}$
Data (Contractor)	Total Cost = $10300\ Q^{.171}$

Despite the apparent quantitative basis of these parametric models, an analogy-based allocation method was used at the subsystem level to generate the models. The SAI report assumed that the following percentages of the above procurement support costs were nonrecurring: 33 percent of system engineering/project management costs, 100 percent of tooling/test equipment costs, 0 percent of test and evaluation costs, and 75 percent of data costs. These percentages were then used, with the above models, to generate estimates of nonrecurring costs. The ramifications of this approach are unclear, and the ramifications were not investigated by the SAI report. Notice also that this effort is a mixing of nonrecurring and recurring costs of dual sourcing. Therefore, it is also unclear how useful this particular set of models may be in a dual sourcing situation.

MLRS Analysis

In December 1980 a study was completed which examined the potential effects of dual sourcing the expendable launch pod containers for the MLRS.[5] The study examined alternative procurement strategies, production rates, total quantities, schedules, and other considerations on an equal effectiveness, unequal cost basis.

Four major competitive acquisition strategies were evaluated in the study. The first was a traditional technical data package (TDP) copy approach which involved obtaining a validated data package from the developer, solicitation of a potential second source via educational buys, and a competitive selection for the remaining program quantity. The second option was a TDP leader/follower approach in which second source contracting begins during the first source's development of the data package so that competition can occur sooner. The third and fourth options were variations of a "freedom of design" (FOD) or a form-fit-and-function approach. Boeing had provided their own design for the MLRS during the validation phase but had lost the contract to Vought. The third option examined the feasibility of Boeing building rockets of its own design but specified to function with the Vought launcher. The fourth option involved providing the second

---

[5] "MLRS Second Source Rocket Acquisition Study," System Planning and Evaluation Division, U. S. Army Missile Command, December 1980.

source with an unvalidated TDP from Vought and requiring that the second source's rockets function with the Vought launcher. These four acquisition strategies were denoted as TDP-traditional, TDP-leader/follower, FOD-designated, and FOD-competitive.

In addition to examining the economic issue of costs for the alternative strategies, the study evaluated program and contractual issues (schedule impacts, configuration management, warranties, first source cooperation, and allied coproduction) and technical and operational issues (availability of second sources, innovation potential, logistic considerations, risk assessment, testing requirements, and TDP validation requirements).

The structure of additional nonrecurring costs due to dual sourcing which was used in the MLRS analysis is shown in Table 2.2. This structure was predicated primarily upon the availability in this form of data from prior proposals.

Table 2.2

Nonrecurring Cost Elements of MLRS Analysis

Contractor research and development

Contractor systems engineering/project management/PEP

Contractor technical data package validation

Prime support to second source

Government research and development/GFE

Government production qualification test

Initial production facilities

The additional nonrecurring costs for each of the cost elements in Table 2.2 were estimated using analogy-based techniques. This methodology was chosen because of the extensive proposals which had been prepared by both Boeing and Vought during the validation phase of the MLRS program. Also, substantial portions of the MLRS system were relatively new developments with little valid historical data to provide a database for parametric modeling. For most cost elements, the costs incurred by Vought as the first source were used as a basis for modification in order to generate estimates of the additional nonrecurring costs of the second source. For the FOD-designated acquisition strategy, the Boeing proposal was used as the basis for several of the cost elements. At all times, the analysis was careful to attempt to establish confidence intervals on the cost estimates even though they were generated using analogy-based techniques. Table 2.3 shows the 90 percent confidence bounds on additional nonrecurring costs of dual sourcing at various production rates for the desired acquisition strategies. This table indicates the large variation in estimates of nonrecurring costs with changes in acquisition strategy as well as production rate.

Table 2.3

MLRS Nonrecurring Cost Estimates

(FY80$M)

Option	Production Rate Per Month			
	2000	3000	4000	6000
TDP-traditional	19-37	21-41	22-45	24-51
TDP-lead/foll	25-48	27-52	28-56	30-62
FOD-designated	74-104	76-105	78-106	80-107
FOD-competitive	86-117	89-124	91-125	93-131

KEY COMPONENTS OF NONRECURRING COSTS

One of the primary research questions of the current analysis is to determine if any of the cost elements encountered thus far are dominant. The studies which provided the most extensive breakdowns of nonrecurring costs into components were the AIAAM study and the MLRS study. Table 2.4 shows the percentage breakdowns of additional nonrecurring costs due to dual sourcing which were attributable to the components used by those studies. The percentages shown are averages across different procurement strategies, production rates, total buys, and other factors discussed in the studies.

Table 2.4

Components of Additional Nonrecurring Costs

Component	Study	
	AIAAM	MLRS
Tooling and Test Equipment	32	40
Test and Evaluation	56	10
Systems Engineering/Project Mgmt.	*	30
Data	12	5
Prime support	-	15
Total (percent)	100	100

* = included in test and evaluation

\- = not included

The largest percentage of costs from the AIAAM study were found in test and evaluation while the largest percentage of costs from the MLRS study were found in tooling and test equipment. As the table indicates, the AIAAM study grouped project management costs with test and evaluation costs. Even if MLRS project management costs were added to test and evaluation costs, tooling and test equipment would still remain the largest component for MLRS.

THE STRUCTURE OF NONRECURRING COSTS

The nonrecurring costs of dual sourcing, in general, include both development costs as well as production costs. This is because the structure of nonrecurring costs will depend upon the acquisition strategy for the particular weapon system under consideration. As the examples above indicate, very different cost element structures have been used for collecting nonrecurring cost data. If there is to be any progress in modeling these nonrecurring costs, a reasonably standard cost element structure must be adopted to ensure compatibility of cost elements across systems.

An excellent example of a structure for nonrecurring production costs is provided by the TRITAC cost element structure. This structure separates these nonrecurring production costs into those costs accruing to the contractor and those costs accruing to the government. Second source nonrecurring costs may generally be comprised of project management, training, production start-up, data, and test and evaluation/technical support costs. Government costs are generally comprised of GFE and test and evaluation costs. The complete TRITAC cost element structure is included in the Appendix. Further details on that particular structure may be found there.

Using the TRITAC structure as a basis, a prototyope structure for nonrecurring cost elements incurred in dual sourcing was developed. This suggested structure is shown in Table 2.5. This

Table 2.5 Structure for Nonrecurring Costs

Government Costs
- Source selection and qualification
- Test and evaluation
- Contract administration
- Project management
- Contingent liabilities

Second Source Costs
- Bid and proposal
- Research and development
- Data
  - Technical manuals and drawings
  - Engineering
  - Management
- Production startup
  - Tooling (initial versus rate)
  - Production engineering
  - Facilities
- Test and evaluation
  - Equipment (initial versus rate)
  - Technical support
- Training
- Project management

First Source Costs
- Technical transfer and coordination

structure includes any costs which require the use of resources. As will be discussed below, the use of particular resources may not require budgetary expenditures, but such uses will always have costs.

Government costs will be discussed first. Almost all costs of dual sourcing currently incurred by the government are absorbed as overhead costs or indirect costs of supporting the dual sourcing. As long as each of the different government offices or locations discussed below is functioning at full capacity prior to the imposition of the additional costs required to support the dual sourcing decision, then these additional costs will force total costs for that government office or location to increase. On the other hand, if that office has some excess capacity then perhaps total costs may not increase due to the additional support required by the dual sourcing decision. If the dual sourcing requires only additional personnel time in an office not functioning at full personnel capacity, then total costs incurred by the government will not increase. If, however, dual sourcing requires additional travel or printing expenses then costs incurred by the government will increase. Historically, such government-incurred costs, even when they have resulted in an increase in budget requirements for particular offices, have not been documented as being a direct result of the increased support required by dual sourcing. In order to fully account for all the costs of dual sourcing, such documentation is essential.

The organization of the program manager's office is also a major determinant of how these additional costs may be incurred. If, for example, the program manager's office uses a matrix concept where the program manager obtains some supporting resources from other elements of a larger organization, it will be much easier for these increased dual-sourcing support costs to be incurred indirectly via the larger organization. If, however, the program manager's office is functionally organized with all resources controlled by the program manager, it is more difficult for the increased dual-sourcing support costs to be incurred in any indirect fashion.

The first government cost which is incurred is that required for second source selection and qualification. These are costs associated with the Procurement Contracting Office's efforts to find and qualify a second source. These costs, although usually not broken out separately but simply absorbed into government overhead costs, are surely costs which are attributable to the government's efforts to provide competition. An example of such a cost is the additional personnel necessary at the PCO in order to perform this additional work.

During the qualification process, it is necessary for the government to test the initial items which are produced by the potential second source. Usually, such tests are performed by some government laboratory since this is the primary source of such in-house expertise. However, such tests may be performed by a contractor. Again, these are costs which must be incurred, regardless of the agent performing them. If the government performs such tests, the costs are usually absorbed into government overhead costs; however, contractor support and travel costs are not usually absorbed into overhead. Additionally, the government may need to validate the technical data package released by the first source to determine if the second source can produce the system from the data provided. Finally, it may be necessary for the government to provide initial training for its own personnel on new test equipment.

Once the second source has been qualified, the government must set up an Administrative Contracting Office or add to the resources of an existing ACO in order to administer the contracts resulting from the establishment of a particular contractor as the second source. An example of such costs are the costs of augmenting or creating a Navy/Air Force Plant Representative Office or a Defense Contracting Administration Service Management Area office.

The government program manager also experiences additional costs due to the existence of the second source. To the extent that such costs are primarily contract administration costs, they are included in the costs listed immediately above. If, however, these costs result from technical or engineering problems such as configuration control of the second source's production line setup, these costs will be entirely separate from contract administration. Such costs are usually absorbed within the office of the government program manager or the command within which the program manager's office resides.

Finally, the government may be liable for any facilitization costs incurred by the first source which may become unrecoverable because of the start-up of the second source.[6] The start-up of the second source, unless planned for very early in the system life via the acquisition strategy, may result in a reduction in the planned production rate for the first source. Historically under sole sourcing, such costs have been absorbed by the government

---

[6] This contingent liability was noted in R. J. Hampton, "Price Competition in Weapons Production: A Framework to Analyze Its Cost-effectiveness," Air University Research Report No. AU-ARI-84-6, June 1984.

through an increase in unit costs since such fixed costs have been spread over a fewer-than-planned number of units. If, however, the government has included the planned rate in a contract for purchase of long-lead-time items or in a multi-year contract, then the first source may have a valid legal position to recover such costs from the government whenever the government starts up a second source. Note that if second sourcing is a part of the initial acquisition and is planned well, such potential problems should be minor if existing at all.

The first costs incurred by the potential second source are those associated with the preparation of the bid and proposal for the second source contract. These costs are readily identifiable but are added to the overhead account and so are allocated across all contracts at that plant. Hence, other government and commercial contracts at that plant end up with an allocated share of the bid and proposal costs for the potential second source contract.

After selection of the second source, the contractor can begin the process of setting up the production capabilities necessary for the weapon system. This setup must be in accord with the acquisition strategy which is being used by the program manager. It may be the case that the program manager has determined that a form-fit-and-function strategy is appropriate for the second source. If so then there may be a requirement for additional research and development expenditures on the part of the second source. If, however, the program manager is using a "complete" technical data package strategy for the second source, it is unlikely that any research and development expenditures will be required on the part of the second source. This cost element is highly dependent upon the acquisition strategy selected by the program manager.

The next major cost component is that associated with the transfer of data from the first source to the second source. Several elements are important here. Technical manuals and drawings must be prepared for the production line based upon information received from the first source or the government. These may require changes due to the configuration of the production line of the second source relative to that of the first source. If so, some engineering modifications of the data will be necessary. Additionally, there are costs associated with the transfer of data necessary for the management control of the production line. It is highly likely that such systems will require rework when transferred from the first to the second source. These elements also depend heavily upon the acquisition strategy selected by the program manager. If the program manager selects an acquisition strategy which requires little or no data transfer then these elements may be of little or no importance. If, however, the acquisition strategy requires transfer of a "complete" or Level 3 technical data package then these elements may be costly.

The next major component of costs are those associated with the physical start-up of the production line by the second source. The second source must purchase the initial tooling required for the production start-up. This should not include any recurring costs which may be associated with rate tooling. This separation of initital from rate tooling may be difficult because of both definitional and timing problems. However, as noted above it is important that the nonrecurring portions of costs be separated from the recurring portions in order to perform the second sourcing analysis. Additional costs are required for the engineering necessary to set up the production line tooling and machinery and to balance the output among the various stations. Finally, start-up costs may result from the necessity to provide any new facilities for the production line of the second source.

Test and evaluation costs incurred by the second source must also be included. These costs can be divided into two elements. The first element is that of initial test equipment required by the second source in order to perform the testing required by the contract. As above, any test equipment depending on the production rate should be included in recurring costs. The second element of test and evaluation costs is that representing any technical support required from other shops within the contractor's plant in order to carry out the test plan. Depending upon the contractor's accounting system, such costs may be absorbed into overhead accounts.

The second source may also be required to provide training to its personnel in order for them to operate any new production line equipment or test equipment. Any training costs which are anticipated to depend upon quantity or rate considerations should be classified as recurring costs.

Finally, the second source must incur costs associated with project management of the contract. This includes systems engineering or PEP costs which are related to support for the second source's project management team.

The first source may also incur additional costs because of the second source decision. If the acquisition strategy calls for heavy reliance upon the transfer of a technical data package, the first source may encounter significant additional costs in preparation of the data package for an external user. Regardless of the acquisition strategy, the first source may be called upon to provide expertise to the second source. Such consulting expertise must be accounted for in the cost structure.

SUMMARY

This chapter reviews current estimation practices, present several models of nonrecurring costs, and analyze the key components of nonrecurring costs experienced by several programs. The dificult task of estimating nonrecurring costs was made even more difficult by the use of inconsistent methods in cost classification and aggregation. In Chaoter 5 we will present our conclusions and recommendations concerning nonrecurring costs in dual sourcing.

CHAPTER 3

PRICE GAMING UNDER DUAL SOURCE COMPETITION

A key issue facing the program manager in charge of a dual source program is the allocation of annual quantity requirements among the competing suppliers. The quantity split issue is crucial for two reasons. First, it affects the amount the Government pays for its weapon system requirement. Second, it affects the contractor's bidding strategy in its pursuit of profit to compensate the investment. This chapter discusses the relationship of dual source quantity-split method and potential price gaming strategies. Actual step-ladder bid data from three major programs will be analyzed to validate the hypothesis.

MINIMUM SUSTAINING RATE

In a dual source competition environment, the low bidder is typically awarded the major portion of the annual buy, but the higher bidder is assured award of at least part of the buy. The portion of the award that is guaranteed represents the minimum level of production the contractor requires to stay in production and remain viable. This guarantee, resulting from the desire to maintain two viable production source, may diminish competitive pressures and put the government in a disadvantaged position.

Due to the splitting of the production quantity between the contractors, the Government must forego some of the savings associated with cumulative production experience. The smaller production rate also means higher unit cost because neither firm is able to fully realize the economies of scale. Therefore, the split award should result in higher production cost than awarding the entire year's production buy to the low bidder for the given year. The argument for using dual source competition, of course, rests on the assumption that the bid prices should be lower under competitive environment, compared to sole source acquisition, thus resulting in net savings to the Government.

MINIMIZATION OF TOTAL COST TO THE GOVERNMENT

The dual award method typically involves solicitation of bids for various portions of the total buy. For example, bids for 30%, 50%, and 70% of the annual quantity may be requested. The logical and widely used quantity allocation method involves computing the total cost to the government for each quantity combination and selecting the least cost alternative.[7] The following example illustrates this common practice:

Table 3.1

Minimum Total Cost Rule Example

Contractor X			Contractor Y			Total
Quantity	Bid	Total	Quantity	Bid	Total	Cost
30	$70	$210	70	$60	$420	$630
50	60	300	50	70	350	650
70	50	350	30	80	240	590 *

As can be seen from the example, the most economical alternative is to award 70 units to Contractor X, the low bidder, and 30 units to Contractor Y, the high bidder.

This method would ensure that the government incurs only the

---

[7] See J. A. Muller, "Competitive Missile Procurement," Army Logistician, Vol. 4, No. 6. (November-December 1972).

minimum cost possible under a dual award environment. However, as mentioned earlier, the minimum sustaining rate diminishes competitive pressures and creates an opportunity for suppliers to manipulate their bid prices.

PRICING STRATEGIES UNDER DUAL AWARD ENVIRONMENT

A major objective of a business firm is to seek highest return possible for its investment. Therefore, given an opportunity, a contractor can be expected to utilize pricing strategy in bidding, either at the expense of the Government or its competitor, in order to maximize its returns. This section discusses several possible ways of price gaming.

Front Loading

The award of minimum sustaining quantity to the high bidder encourages the contractor to inflate its bid price beyond a reasonable amount for quantities at or near this minimum rate. A newly developed second source, knowing too well that it is not in a position to compete with the established original source for a major portion of the annual buy, may be content with the minimum sustaining rate and therefore would have the incentive to submit a competitive bid.

Even for the established original source, the competitive pressure does not exist is the award of the minimum sustaining rate is assured.

The use of minimum total cost method for quantity allocation also encourages the contractor to "front load" the bids. By raising its bids on the smaller quantities, a contractor can increase its chance of getting the larger portion of annual buy. This can be demonstrated by raising the high bidder's bid for low quantity from $80 to $95, as shown in Table 3.2. Such pricing manipulation may result in award of the larger portion of annual buy to the high cost bidder.

Table 3.2

Front Loading Pricing Example

Contractor X			Contractor Y			Total
Quantity	Bid	Total	Quantity	Bid	Total	Cost
A: No Price Gaming						
30	$70	$210	70	$60	$420	$630
50	60	300	50	70	350	650
70	50	350	30	80	240	590 *
B: With Price Gaming						
30	$70	$210	70	$60	$420	$630 *
50	60	300	50	70	350	650
70	50	350	30	95	285	635

End Loading

A contractor may inflate its bid price of the large quantity if its production capacity is pushed. End loading may also occur if the contractor believes that there is a lack of price competition. For example, the original source may inflate its bid prices of the large quantity knowing full well that the second source does not have enough production experience to be the low bidder or that the second source was not facilitized to compete for that quantities.

Price Inflation Over the Entire Quantity Range

The per unit production cost of most weapon systems normally decreases systematically along a learning curve. Therefore, if the contractor's profit margin is constant, such as in a system procured under a cost-plus contract, the Government can expect to follow a reasonably smooth price reduction curve.

However, under the firm-fixed-price contract, the contract type used in most dual source competitions, the contractors are not required, nor are they expected, to charge a constant profit margin. Prior research on contractors' pricing behavior has shown that profitability of defense business is a function of the defense industry's economic condition and that the variation of prices the Government paid for weapon systems can be explained by the variation in contractors' profit margins. Therefore, we may expect that, during an economic boom, the contractor's bids may be consistently above what was expected along the price reduction curve.

ANALYSIS OF STEP-LADDER BID PRICES

The three price gaming strategies discussed above may be illustrated graphically. In a log-log graph such as Figure 3.1, the long term price reduction curve for a system may be approximated by a linear function such as line AB. The bid price for various quantities in a particular year may be approximated by line CD, assuming the production cost decreases at a constant rate and the profit margin is constant from year to year. The steeper slope for line CD may be explained by the effect of production rate. Lines AB and CD should intercept at point I, which represents the normal production rate used in the determination of the long term price reduction curve, AB.

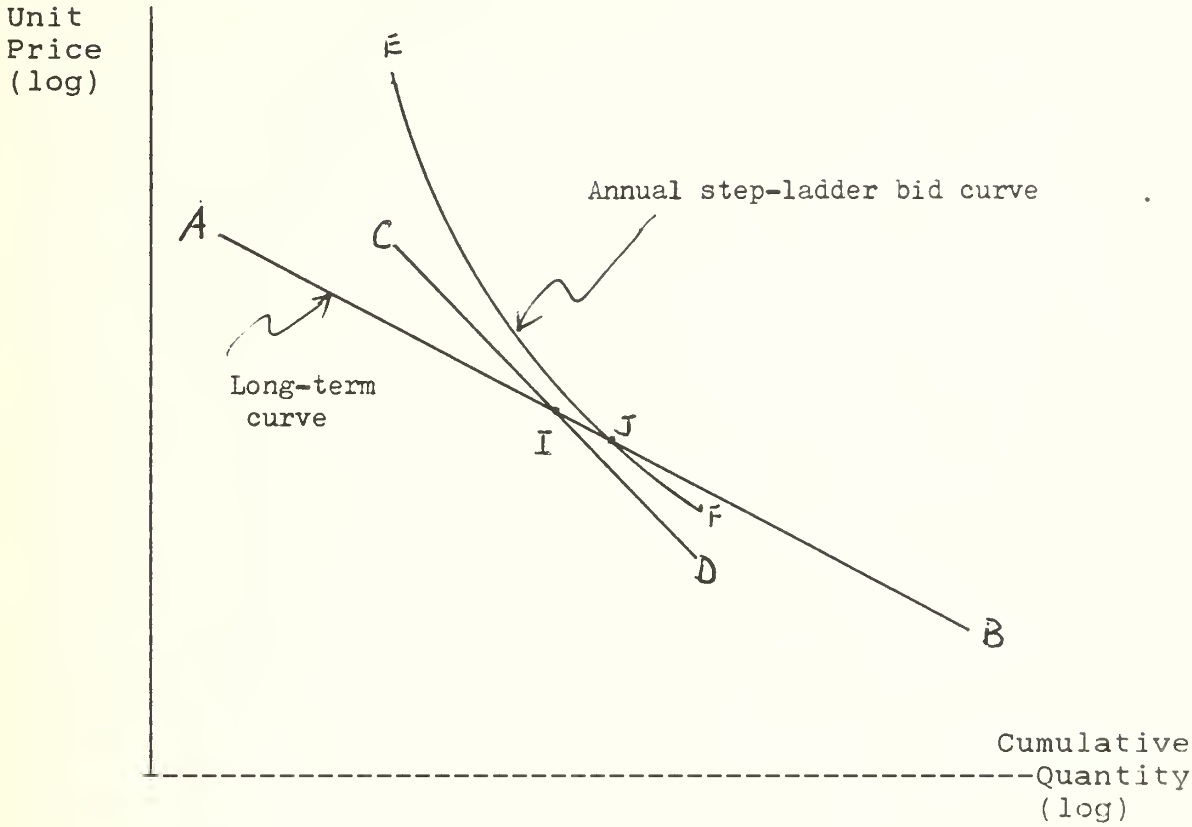


Figure 3.1 Price Gaming Strategies Illustrated

Line EF shows what the step-ladder bid price should look like if all three types of price gaming strategy are used. Note that line EF is convex and lies above CD. Front loading is reflected in the line curving up toward E, which lies above C. Ending loading is reflected in the line curving up toward F which, again, lies above D. Line EF intercepts line AB at point J, which lies to the right of point I, indicating bid price inflation over the entire range of quantity spread.

Empirical Evidence of Price Gaming

To see whether or not the bid price gaming strategies hypothesized above were used and the extent of their use, the step-ladder bids of three major systems were analyzed. In order to avoid disclosing competition sensitive data, the identities of the programs and contractors are masked and the numbers are altered. Actual data can be found in Part II of this report.[8]

Since there are two suppliers for each program, data from six contractors are available. Figures 2.2 through 2.7 depict the step-ladder bid prices submitted by each contractor, along with the long-term price reduction curves as reflected in actual contract awards. All numbers are based on constant dollars, using DoD escalation indices for price level adjustment.

Front loading, reflected by the steep upward bend at the low end of quantities, can be observed in virtually every case examined, with the possible exception of Program Y Contractor B (see Figure 3.5). End loading is also evident in virtually every case examined, but particularly noticeable in Program X, Contractor B's Year 1 quote (Figure 3.3) and all quotes related to Program Z. As to the third type of price gaming, i.e., submitting bids which are higher than the preceding year's bids, the evidence can be found in Figures 2.3, 2.6, and 2.7.

SUMMARY

This chapter discusses two problems inherent in using dual source competition as a price reducing tool in major system acquisition. The award of the minimum sustaining quantity to the high price bidder and the desire to minimize the total cost

---

[8] Distribution of Volume II is limited to Department of Defense agencies only.

to the government in quantity allocation diminish competitive pressures and give the contractors an opportunity for price gaming. Three possible ways of price gaming are discussed. An analysis of the step-ladder bids of three major systems clearly shows the use of these pricing strategies by the suppliers of these systems.

FIGURE 3.2

PROGRAM X – CONTRACTOR A

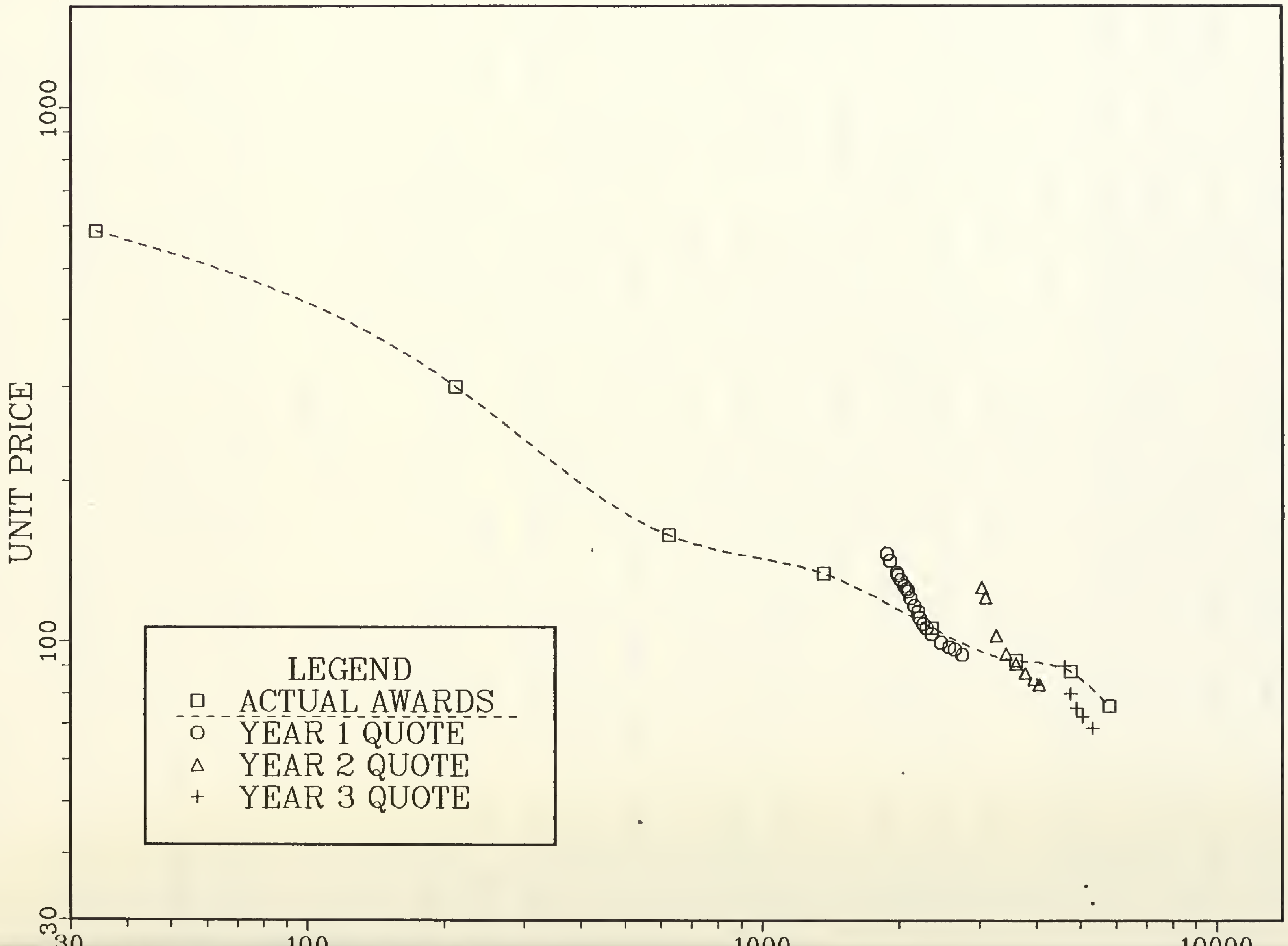


FIGURE 3.3

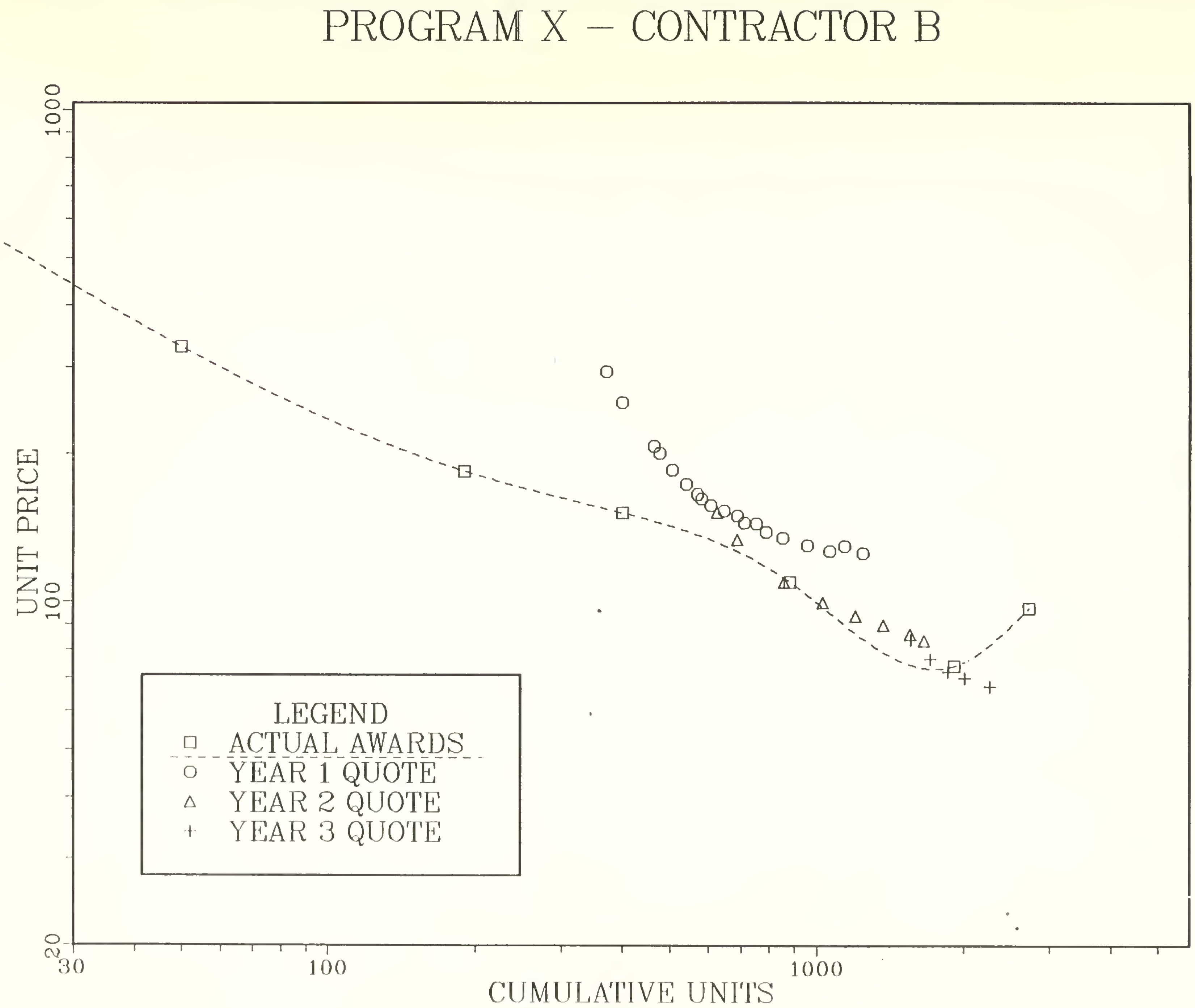
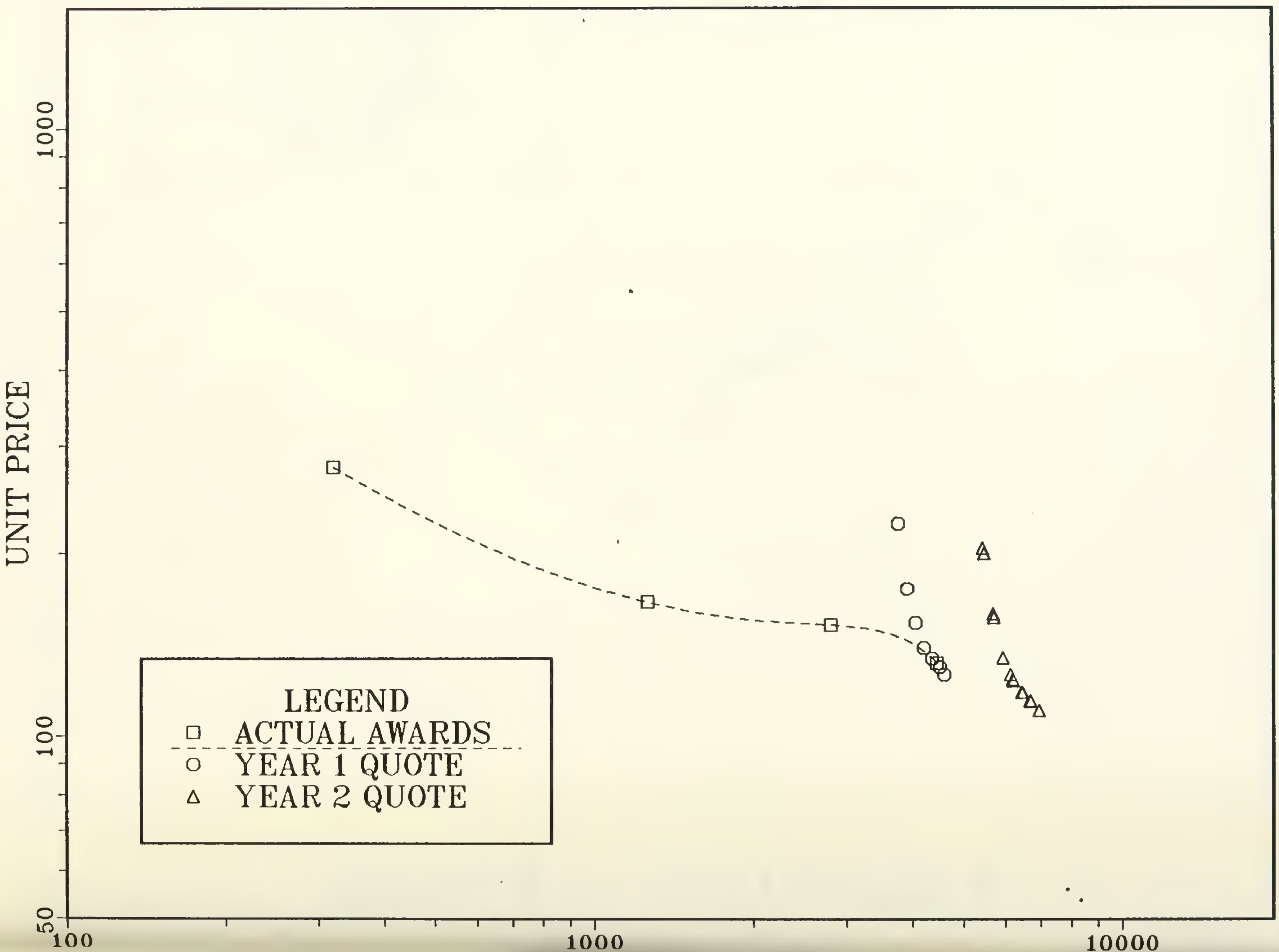

PROGRAM X – CONTRACTOR B
UNIT PRICE
1000
100
20
30
100
1000
CUMULATIVE UNITS
LEGEND
ACTUAL AWARDS
YEAR 1 QUOTE
YEAR 2 QUOTE
YEAR 3 QUOTE

FIGURE 3.4

PROGRAM Y – CONTRACTOR A



PROGRAM Y – CONTRACTOR B

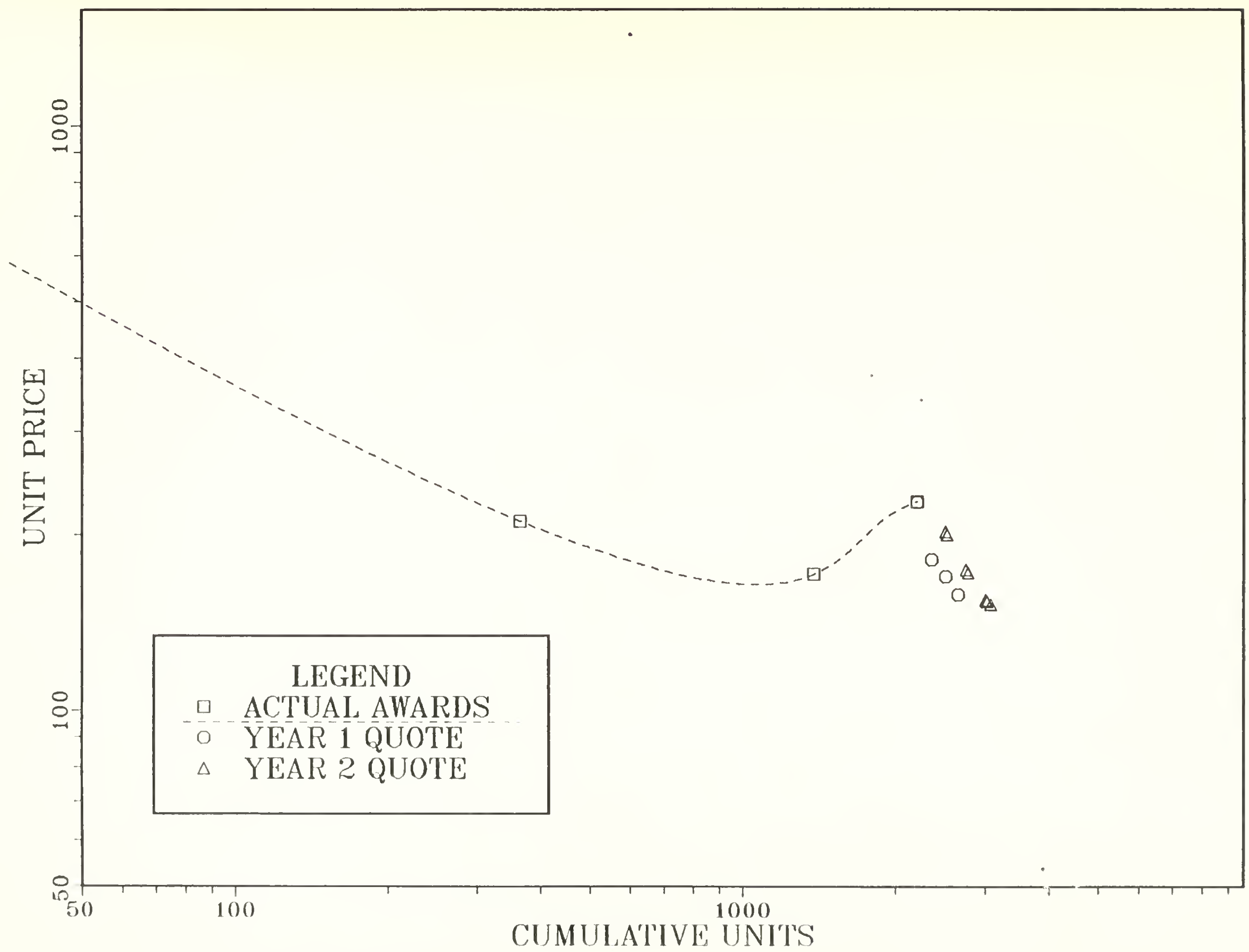
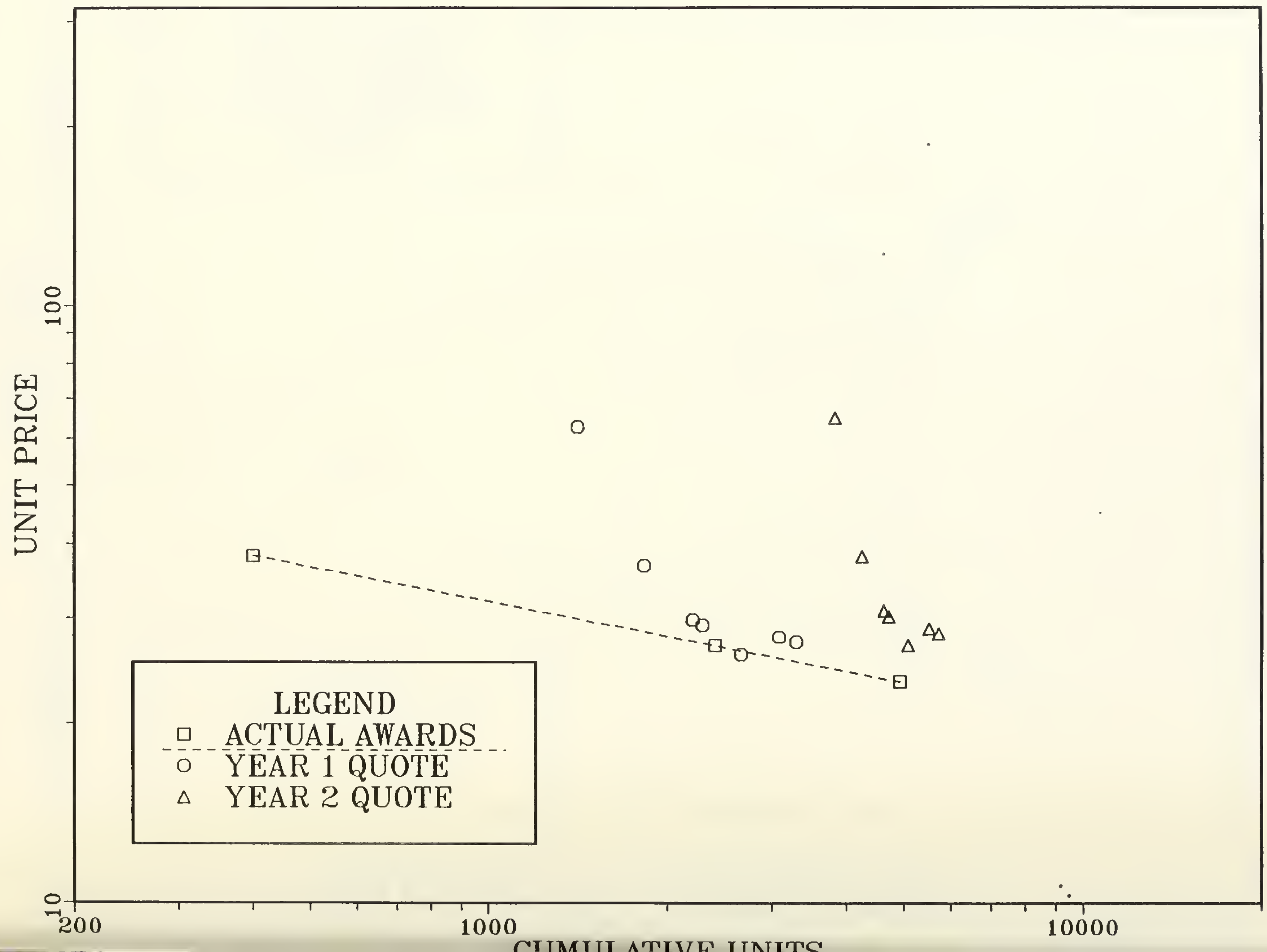
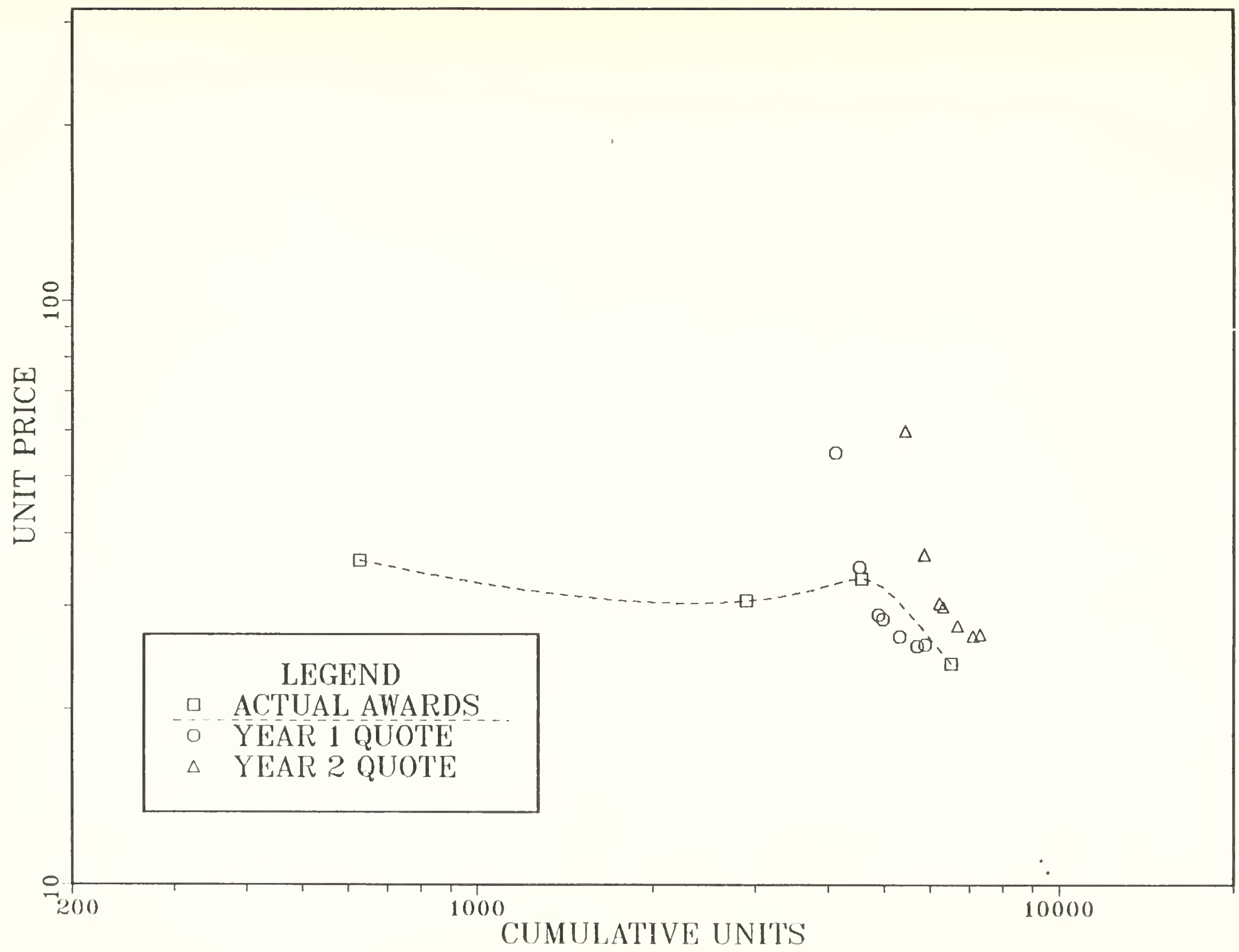


FIGURE 3.6

PROGRAM Z – CONTRACTOR A



PROGRAM Z – CONTRACTOR B



CHAPTER 4

ANALYSIS OF DUAL AWARDS QUANTITY-SPLIT MODELS

Given the inherent weakness of using the total minimum cost rule to allocate annual buy, a number of alternative quantity-split models were developed and used in various programs. This chapter examines the methodology and the strength and weakness of these dual award models.

The performance of these models are examined from two different angles. First, The step-ladder bid data of two major programs, designated as Program X and Program Y in this report, are utilized to see what would have happened had each of these models been used in allocating annual quantities. The total cost to the government under each method is then used to judge the cost performance of each model. Second, each of these models is examined to see if it is effective in dealing with the bid price gaming strategies discussed in the preceding chapter.

The following assumptions are made in order to make all quantity-split models applicable to both programs:

(1) Each contractor will be able to deliver all quantities of items it has bid on in a timely manner and in the condition as specified in the contract. This will hold the bidding contractors to the terms of the solicitation and contracts issued.

(2) The items produced by each contractor will be assumed to be identical in performance characteristics and technical specifications. This places the contractors on an equal basis concerning the quality of the item and enables us to evaluate the award model on the basis of price factors.

(3) The minimum sustaining rate for the programs will be set at 10% of the total annual buy. This will enable us to see what would have happened under the most severe quantity-split condition.

(4) The type of contract that will be issued to the competing contractors is a firm-fixed-price contract unless otherwise specified.

MINIMUM TOTAL COST RULE

Method

As mentioned in the preceding chapter, using the minimum total cost rule is relatively straightforward. The first step is to solicit bids for specified quantities or percentages of the annual quantity requirements. After bids are received, the second step is to evaluate the total cost to the government for each quantity combination. The quantity combination with the lowest cost to the government is then selected for contract award.

Result

Applying this rule to Programs X and Y, the lowest cost quantity-split combination for each year can be computed from the step-ladder quotes of these two programs. The results may be summarized as shown in Table 4.1.

Table 4.1

Quantity-split & Cost Using Minimum Total Cost Rule

Year	Split	Prices	Total Price
		Program Y	
1	A - 90%	$239,976,420	
	B - 10%	45,214,591	285,191,011
2	A - 90%	343,333,296	
	B - 10%	67,496,390	410,829,686
		Program Z	
1	A - 90%	$96,599,682	
	B - 10%	26,274,360	$122,874,042
2	A - 30%	46,372,747	
	B - 70%	79,676,290	126,049,037

THE SOLINSKY METHOD

In order to achieve effective competition while preserving an industrial mobilization base, Solinsky develop a mathematical model for use by the Army Electronics Command Night Vision Laboratory during the competitive production of the AN/PVS-5A.[9]

Method

Solinsky's method was intended to enhance aggressive bidding by relating the split in the procurement quantity to the difference in bid prices between the two suppliers. If the differen-

---

[9] Kenneth S. Solinsky, "A Procurement Strategy for Achieving Effective Competitive Competition While Preserving an Industrial Mobilization Base," undated report, Army Electronics R & D Command, Nigh Vision and Electro-Optics Laboratory.

tial between the two contractors' bids is large, the percentage share differential is large.

The bid differential, x, is calculated from bids at 50:50 split using the following equation: (assuming A has the low bid for the midrange quantity)

$$x = \frac{\text{Contractor B Price} - \text{Contractor A Price}}{\text{Contractor B Price} + \text{Contractor A Price}}$$

The percentage share of quantity for contractor A is calculated according to an arc-tangent function as shown below:

$$f(x) = \left[\left(\frac{a(x)}{x}\right)\left(\frac{\tan^{-1} b\,(x)^{c}}{90}\right) + 1\right] / 2$$

where a, b, and c are coefficients that can take on various values, depending on the severity of quantity split desired. The f(x) function may be portrayed as a four-quadrant diagram.

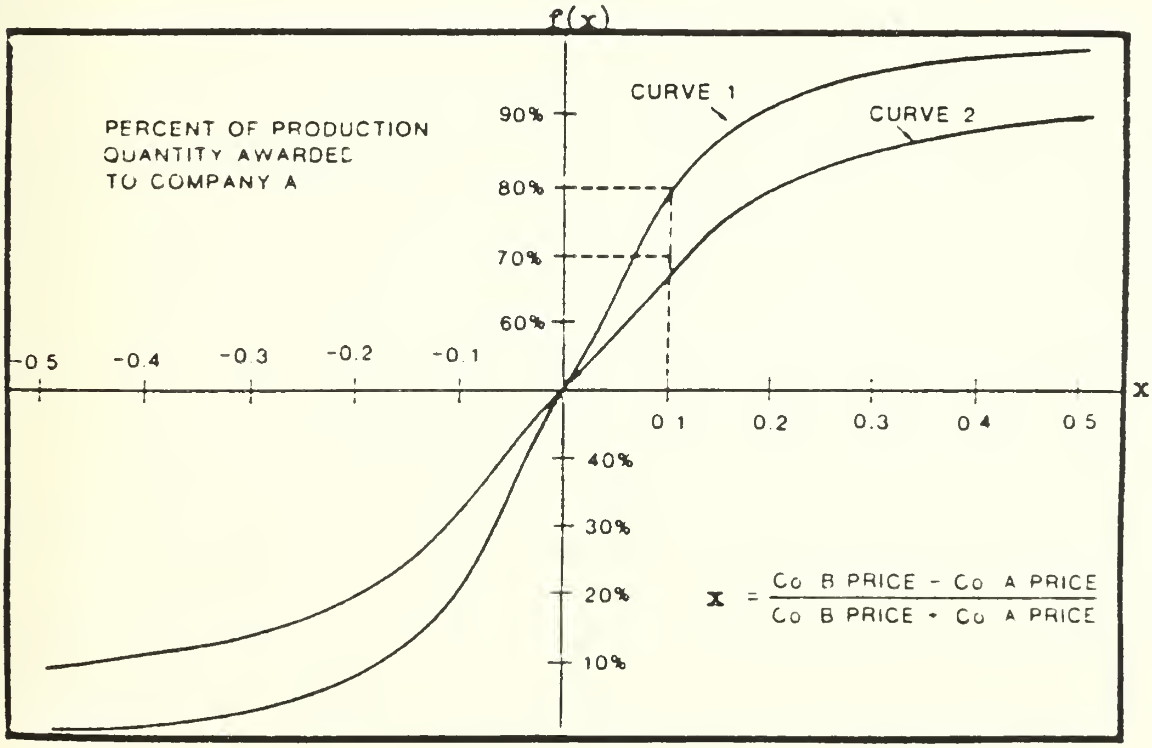


Figure 4.1 Solinsky's Allocation Method

As shown in Figure 4.1, the ratio of price differential, or x, is presented along the horizontal axis, while the percent of quantity awarded to Contractor A, the low bidder, is shown along the vertical axis. A series of arc-tangent curves, such as curve 1 and curve 2 in Figure 4.1, can be drawn by the acquisition manager by varying the values of a, b, and c in f(x). For example, if the acquisition manager determines that the most severe split of 90:10 will occur when the price of one of the contractor is 25% higher than that of the other, a = 1, b = 25, and c = 1. The equation may be rewritten as follows:

$$f(x) = [(\frac{1(x)}{x}) (\frac{\tan^{-1} 25\ (x)}{90}) + 1] / 2$$

Assuming the bids by the two contractors for 50% of the quantity are $154,693 and $134,508 respectively, the price differential is

$$x = \frac{154,693 - 134,508}{154,693 + 134,508} = 0.0697957$$

Substituting 0.0697957 into the equation,

$$f(x) = [(\frac{.0697957}{.0697957\ x}) (\frac{\tan^{-1} 25\ (.0697957)}{90}) + 1] / 2$$

$$= 0.8343 \quad (\%\ \text{of quantity for Contractor A})$$

Result

Table 4.2 shows what the allocation of quantity and total cost to the government would have been had Solinsky's allocation method been applied to Programs Y and Z.

Table 4.2

Quantity Split & Cost Using Solinsky Rule

Year	Split	Prices	Total Price
		Program Y	
1	A - 81.27%	$134,215	
	B - 18.73%	227,209	$301,278,973
2	A - 83.43%	117,950	
	B - 16.57%	199,560	439,088,330
		Program Z	
1	A - 61.04%	28,504	
	B - 38.96%	36,746	133,143,704
2	A - 56.70%	29,873	
	B - 43.30%	38,035	140,253,532

THE PELZER METHOD

It has been suggested that price competition may force contractors to trade off cost and quality, thus leading to potential reduction in system performance. Pelzer developed an allocation model to reduce this potential risk by incorporating quality and other relevant factors into the award formulation.[10]

Pelzer argued that the system developer will enjoy considerable production experience relative to the second supplier and, therefore, the latter could not be price competitive. To adjust for this, Pelzer develops an index weighting system which emphasizes relative price decreases over three-year period. The method was

---

10 Jay L. Pelzer, "Proposed Allocation Technique for a Two-Contractor Procurement," Air Force Institute of Technology, May 1979.

used in the acquisition of GAU-8 ammunition.

Method

The first step in Pelzer's method is to identify certain competitive or performance factors of each contractor's product and assign weights to each factor. These factors may include performance characteristics, delivery and quality performance, and technical specifications. These factors are used in computing the annual competitive index for each contractor as part of the award formulation. Since it is assumed in this study that the items produced by both contractors are identical in quality, these factors will be irrelevant in our comparison of model performance.

Bids were requested from each contractor for various percent of quantity. The bid prices are then fitted to a quadratic equation to reflect the effect of production rate changes on unit prices. The average unit price (AUP) for each contract's bids in a given year is then computed by integrating the equation over the interval of the percent quantity split range (90% to 10% in this study) and then dividing by the length of this range (0.8).

AUP is then adjusted for other qualitative factors to determine an annual Competitive Index as shown below:

$$CI_a = (AUP_a)\,(F_1)\,(F_2)\;.\;.\;.\;(F_n)$$

where: CI_a = Contractor A's Competitive Index

AUP_a = the average unit price bid for Contractor A

F_1 through F_n are qualitative factors.

Since it is assumed in this study that the items supplied by both contractors are identical in performance, the annual Competitive Index is the same as the average unit bid price.

The annual Competitive Index is used to calculate an Overall Competitive Index (OCI). In computing OCI, Pelzer stresses the contractor's competitive behavior in the two prior years. Mathematically the OCI is computed as follows:

$$OCI_t = (CI_t)\left(\frac{CI_t}{CI_{t-1}}\right)\left(\frac{CI_{t-1}}{CI_{t-2}}\right)$$

The ratio of the lower to the higher OCI is used to graphically determine the quantity split, as shown in Figure 4.2. The procedure entails drawing a 45 degree diagonal line from the origin called OS. Along this line all points would represent an even allocation to each contractor. An arc is then drawn to represent different possible split ratios other than 50:50. A line segment, AB, perpendicular to the horizontal axis is drawn in to account for the 10% minimum sustaining rate, or 90% maximum allocation to the winner. Finally, a line, OS', is drawn from the origin with a slope equal to the ratio of the lower to the higher OCI. From point C, where line OS' intercepts the arc, a line, CD, perpendicular to the horizontal axis is drawn. Reading off the X-axis, Point D represents the percent quantity allocation for the low bidder. The award price would be the bid price corresponding to the quantity allocated.

Result

Table 4.3 shows what the allocation of quantity and total cost to the government would have been had Pelzer's allocation method been applied to Programs Y and Z.

Figure 4.2 Pelzer's Quantity Allocation Method

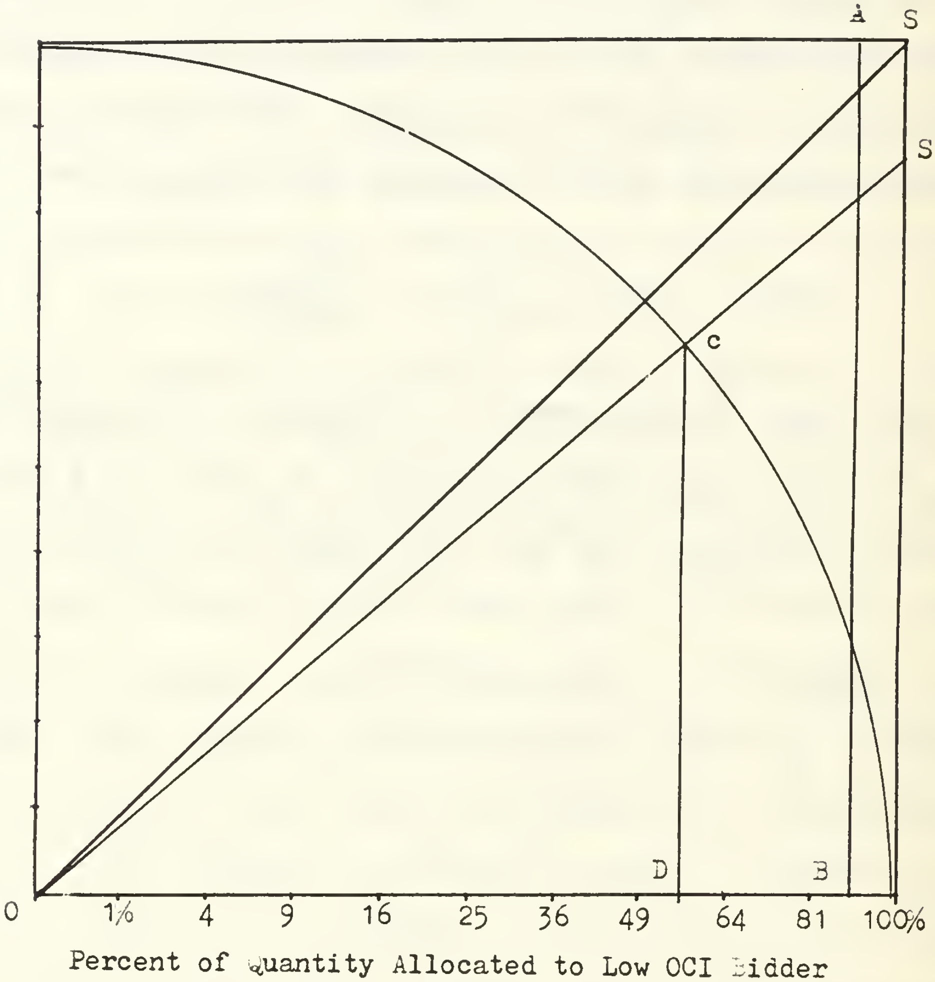


Table 4.3

Quantity Split & Cost Using Pelzer's Method

Year	Split	Prices	Total Price
		Program Y	
1	A - 50%	$153,494	
	B - 50%	168,585	$319,993,032
2	A - 61%	124,032	
	B - 39%	154,693	454,218,163
		Program Z	
1	A - 44%	35,077	
	B - 56%	29,182	133,395,948
2	A - 53%	31,105	
	B - 47%	32,909	141,510,480

THE PRO CONCEPT

The PRO (Profit Related to Offers) Concept was developed by the Navy Strategic Systems Project Office for use during competitive production of the Trident MK-5 Inertial Measurement Unit and Electronics Assembly.[11] The model differs from other quantity-split models in two ways. First, both contractors are awarded fixed price incentive contracts. Second, contractors' profit margins vary according to their bid prices. Therefore, this model is not applicable to the firm-fixed-price contract used in a typical dual source competition environment.

The basic model of the PRO Concept awards equal quantity to

---

[11] K. V. Fleming, "The PRO Concept: A Method of Conducting Competition in Dual Source Procurement Situations," February 1980.

both contractors. However, there were provisions for unequal quantity solicitations to maintain competition and discourage price gamesmanship.[12] To illustrate how the quantity allocation method works, we will assume that the bid prices were contractor cost figure, and an assumed 15% profit will be added to the winning bidder's figure.

Method

The first step under the PRO Concept is to solicit bids from both contractors for specified quantity or % of annual buy. The sum of each contractor's step-ladder bids for various quantities is then calculated to determine the low bidder. The contractor with the low bid sum (LS) will be awarded a profit equal to a specified % (say 15%) of his cost. The contractor with the high bid sum (HS) will be awarded a profit on the basis of the ratio of HS/LS according to a sliding scale such as follows:

HS/LS Ratio	Loser's Profit
1.00 - 1.10	.15LS - .4(HS - LS)
1.11 - 1.20	.11LS - .3(HS - 1.1LS)
1.21 - 1.30	.08LS - .24(HS - 1.2LS)
1.31 & over	.056LS

Once the prices (cost plus allowed profit) are determined, the cost to the government for all possible quantity-split combinations are calculated. The minimum cost rule is used to determine the lowest cost alternative.

---

[12] Op. cit., pp. 25-33.

Result

Table 4.4 presents what the allocation of quantity and total cost to the government would have been had the PRO Concept been applied to Programs Y and Z.

Table 4.4

Quantity Split & Cost Using the PRO Method

Year	Split	Prices	Total Price
		Program Y	
1	A - 90%	$275,972,883	
	B - 10%	49,236,676	325,209,559
2	A - 90%	394,833,290	
	B - 10%	77,995,045	473,236,550
		Program Z	
1	A - 90%	111,089,634	
	B - 10%	28,412,097	139,501,731
2	A - 30%	53,328,759	
	B - 70%	92,702,673	145,031,432

THE DUAL COMPETITIVE AWARD METHOD

The Dual Competitive Award Method (DCAM) was developed by the Air Force's A-10 Program Office during the GAU-8/A ammunition procurement.[13] The distinguishing feature of this model is the use of a price reduction curve in bid solicitation.

Method

---

[13] Darrell R. Hoppe, "Dual Award and Competition -- You Can Have It Both," paper presented at the 1977 Acquisition Research Symposium.

In soliciting bids from the competing contractors for the specified quantities, the DCAM required each contractor to provide a price reduction curve that reflects the bids submitted. It is probably more appropriate to associate this curve with the effect of production rate changes. Terminology aside, this curve is used to extrapolate the unit prices for the allocated quantity.

The bid prices submitted are averaged to arrive at an average bid for each contractor. The percent difference between the high and the low averages is calculated as follows:

$$\% \text{ Difference} = \frac{\text{High Average} - \text{Low Average}}{\text{Low Average}} \times 100$$

The maximum quantity split desired is then determined (90:10 for this study). The percent difference in bid price averages is then applied to a matrix for different allocations. Assuming that the most severe split of 90:10 is to occur when the percent difference is 81% to 90%, with the allocations changing 5% for every 10% decrease in bid differential, the following matrix applies:

% Difference in Bids	Quantity for Low Bidder	Quantity for High Bidder
0 - 10	50	50
11 - 20	55	45
21 - 30	60	40
31 - 40	65	35
41 - 50	70	30
51 - 60	75	25
61 - 70	80	20
71 - 80	85	15
81 - 95	90	10
Over 95%	Negotiations	

Result

Table 4.5 presents the result of quantity allocation and total cost to the government assuming DCAM were applied to Programs Y and Z.

Table 4.5

Quantity Split & Cost Using DCAM

Year	Split	Prices	Total Price
		Program Y	
1	A - 75%	$134,086	
	B - 25%	181,775	$290,130,687
2	A - 80%	116,552	
	B - 20%	177,074	429,713,299
		Program Z	
1	A - 90%	24,878	
	B - 10%	42,016	119,125,891
2	A - 80%	27,262	
	B - 20%	42,016	126,839,504

COMPARATIVE ANALYSIS OF COST PERFORMANCE

This section compares the results obtained from applying each of models discussed above to Programs Y and Z. To facilitate comparison, results shown in Tables 4.1 through 4.5 are rearranged and consolidated, as shown in Table 4.6.

Table 4.6

Comparative Performance of Quantity-Split Models

(in $1,000)

Model	% Share for A	% Share for B	Total Cost
	Program Y (Year 1)		
Minimum total	90	10	$285.2*
Solinsky	81	19	301.3
Pelzer	50	50	320.0
PRO	90	10	325.2
DCAM	75	25	290.1
	Program Y (Year 2)		
Minimum Total	90	10	410.8*
Solinsky	83	17	439.1
Pelzer	61	39	454.2
PRO	90	10	473.2
DCAM	80	20	429.7
	Program Z (Year 1)		
Minimum Total	90	10	$122.9
Solinsky	61	39	133.1
Pelzer	44	56	133.4
PRO	90	10	139.5
DCAM	90	10	119.1*
	Program Z (Year 2)		
Minimum Total	30	70	$126.1*
Solinsky	57	43	140.3
Pelzer	53	47	141.5
PRO	30	70	145.0
DCAM	80	20	126.8*

It can be seen from Table 4.6 that the Minimum Total Cost Rule and the Dual Competitive Award Method seem to be the most effective when both competitors submit bids for the entire quantity range, such as in Program Z. When one of the competitors failed to submit bids for the entire quantity range, however, the DCAM method seems to lose its effectiveness.

It is interesting to note that the total cost to the government is lowest when the quantity split is severe. In three of the four cases shown in Table 4.6, the lowest cost figures are found when the split ratio is 90:10, while the fourth case shows a 70:30 split.

The Solinsky method and the Pelzer method both result in higher cost to the government in comparison to the minimum total cost rule and the DCAM method. Note that the quantity split ratios under the Solinsky method and Pelzer's method are much less severe than the other two models. In order to see why these results came, it is necessary to analyze the strengths and weaknesses of each model.

STRENGTHS AND WEAKNESSES OF EACH MODEL

As discussed earlier in the chapter, the inherent weakness of using the minimum total cost rule to allocate annual procurement quantity led to the development of several alternative quantity-split models. In this section, we will analyze the strengths and weaknesses of these dual award models and evaluate their effectiveness in dealing with the contractor's gamesmanship discussed in Chapter 3.

The Solinsky Method

The Solinsky method is flexible, in that the mathematical equation used in quantity allocation can be adjusted by changing the coefficients of the price difference (x) to determine the severity of the split desired.

However, the method may be flawed for using the midrange (50:50 split) bid point as the basis for quantity split. The contractors stand to gain by using either front-loading or end-loading pricing strategy, or both. If one contractor inflates its midrange bid price, there is a mild penalty. If both contractors use price gaming, however, the penalty is neutralized. Consequently, this method may actually lead to increased cost to the government, as reflected in Table 4.6.

The Pelzer Method

One of the major feature of Pelzer's method is the integration of qualitative factors into the quantity allocation formulation. One may argue that the cost-quality tradeoff function is not widely applicable and the index weighting system is inevitably subjective and arbitrary.

One must admit, however, that relating the award quantity to prior years' prices is a major strength of Pelzer's method. Although the method does not have any specific measures to cope with the three possible price gaming strategies, it recognizes the problem of unreasonable bid prices and makes a modest attempt to address the issue.

The major weakness of Pelzer's method lies in using 50:50 split ratio as the starting point for allocating quantity split, thus leading to relatively mild splits in most cases and higher cost to the government. The pressure of price competition does not exist when the award quantity difference between the high bidder and low bidder is small.

Pelzer's method also suffers from another major flaw in its quantity split algorithm. The quantity allocation computation is based on the low bidder's bids. If the low bidder is penalized for any reason, the penalty represents a windfall to the high bidder.

The Dual Competitive Award Method

The advantage of using DCAM comes from its use of the price reduction curve theory. This method links the bids submitted by the contractors to a price reduction curve for each contractor, in effect making the bids submitted for each quantity level dependent upon each other. This establishes a production rate function for each contractor and, to some extent, reduces the possibility of using front-loading or end-loading the annual bids.

However, the DCAM method does not relate the award quantity to the slope of the production rate curve nor does it relate the award to prior years' prices. Therefore, the method is unlikely to be very effective in coping with price gamesmanship.

SUMMARY

This chapter reviews a number of alternative quantity split models. The performance of these models are examined from two different angles. First, the step-ladder quotes of two major programs are utilized to test what would have happened had each of these models been used in allocating annual quantities. The total cost the government under each method are then used to judge the cost performance of each model. Second, the strengths and weaknesses of each model are examined to see if it is effective in dealing with the bid price gaming strategies in Chapter 3.

The results show that, from the standpoint of cost performance, the minimum total cost rule and the Dual Competitive Award Method seem to perform better than the others. In coping with price gamesmanship, however, only the Pelzer method and Dual Competitive Award Method make a modest attempt to address this problem.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the results of our study and offers general comments about current practices. Suggestions for future plans to further improve the methods of cost estimating and quantity allocation are discussed.

ESTIMATING NONRECURRING COSTS

Nonrecurring costs are a relatively small proportion of total costs. This is shown in Table 5.1 where the only cases in which nonrecurring costs exceed 10 percent are those in which substantial amounts of research and development costs are incurred by the second source.

Table 5.1

Percentage of Costs Which Are Nonrecurring

Study	Acquisition Strategy	Minimum-Maximum
MLRS	TDP-traditional	2-6
	TDP-lead/foll	3-7
	FOD-designated	7-14
	FOD-competitive	8-16
AIAAM	N/A	5-7
Sparrow AIM-7F	N/A	8

It cannot, however, be concluded that changes in nonrecurring costs due to the second sourcing decision are small. Table 5.2 shows the percentage increases in dual source nonrecurring costs over the sole source nonrecurring costs for the same program shown in Table 5.1. These data indicate that dual source nonrecurring costs may increase by more than five times over the estimate of original sole source nonrecurring costs.

Table 5.2

Percentage Increases in Nonrecurring Costs

Study	Acquisition Strategy	Minimum-Maximum
MLRS	TDP-traditional	100-145
	TDP-lead/foll	121-185
	FOD-designated	247-440
	FOD-competitive	297-510
AIAAM	N/A	71-79
Sparrow AIM-7F	N/A	162

It is imperative that fixed cost components be separated from variable cost components in the cost element structure. If this is not done it unnecessarily complicates the process of estimating the nonrecurring costs associated with the dual sourcing decision.

Lastly, it appears that a viable methodology for the current state of data and models of nonrecurring costs is to use analogy-based techniques similar to those used in the MLRS report. That approach estimated confidence bounds on the various cost elements. With such bounds, it is then possible to use the more reliable recurring cost models and data to generate estimates of recurring costs to determine if the recurring cost savings fall outside the confidence bounds established for the nonrecurring costs. In this way, a straightforward method may be used to determine the extent of cost savings resulting from the dual sourcing decision.

DEALING WITH PRICE GAMING

Price gaming by contractor is widely discussed in acquisition circles. In this study, we classified the gaming strategies into three categories: front-loading, end-loading, and price inflation over the entire quantity range. Based on the step-ladder bids obtained from three major systems, we were able to identify traces of the three gaming strategies discussed.

We have shown that the minimum total cost rule in wide practice today is most susceptible to price gaming. Although a number of quantity-split models were developed as an alternative to the minimum total cost rule, only Pelzer's method and the Dual Competitive Award Method made a modest attempt to relate the award quantity allocation to contractors' pricing behavior. From the standpoint of cost performance, however, only the Dual Competitive Award Method was able to perform as good as, or better than, the minimum total cost rule. Therefore, it is reasonable to conclude that none of the alternative models would be effective in coping with the three types of gaming strategies identified in Chapter 3.

The apparent suggestion is that a new model capable of coping with the three price gaming strategies is needed if the government is to realize the benefit of dual source competition. Creating a second supply source involves a substantial amount of front-end investment cost on the part of the government. However, the benefit of a competitive procurement environment may not follow unless an effective quantity-split model is used. We have identified the different methods of price gaming that a contractor may use. It is essential that the new quantity-split model be capable of addressing this issue and ensure that a true price competition will exist when the second source is established.

APPENDIX

TRITAC COST ELEMENT STRUCTURE

100	RESEARCH & DEVELOPMENT
110	DEMONSTRATION & VALIDATION
111	CONTRACTOR
111.11	PRIME MISSION EQUIP (PME)
111.11.1	INTEGRATION AND ASSEMBLY
111.11.2	SENSORS
111.11.3	COMMUNICATIONS
111.11.4	AUTO DATA PROCESSING EQUIP
111.11.5	COMPUTER PROGRAMS
111.11.6	DATA DISPLAYS
111.11.7	AUXILIARY EQUIP
111.11.8	COMMON SUPPORT EQUIP
111.11.9	PECULIAR SUPPORT EQUIP
111.11.10	OTHER EQUIP
111.12	STSTEM PROJECT MANAGEMENT
111.13	SYSTEM TEST & EVALUATION
111.14	TRAINING
111.15	DATA
111.15.2	ENGINEERING DATA
111.15.3	MANAGEMENT DATA
111.15.4	LOG SUPPORT
111.16	INDUSTRIAL FACILITIES
111.16.1	RDTE
111.16.2	MILCON
111.17	SOFTWARE CENTER
111.17.1	RDTE
111.18.2	MILCON
111.18	OTHER
111.18.1	RDTE
111.18.2	O&M
111.18.3	OTHER PROC
111.18.4	PROC
112	GOVERNMENT
112.11	GOVT FURN EQUIP (GFE)
112.11.1	INTEGRATION AND ASSEMBLY
112.11.2	SENSORS
112.11.3	COMMUNICATIONS
112.11.4	AUTO DATA PROCESSING EQUIP
112.11.5	COMPUTER PROGRAMS
112.11.6	DATA DISPLAYS
112.11.7	AUXILIARY EQUIP
112.11.8	COMMON SUPPORT EQUIP
112.11.9	PECULIAR SUPPORT EQUIP
112.11.10	OTHER EQUIP
112.12	PROGRAM MNGMNT
112.12.1	PROGRAM MANAGEMENT MILITARY
112.12.2	PROGRAM MANAGEMENT CIVILIAN
112.12.3	PGM MGT CONTRACTOR SUPPORT
112.13	GVRNMNT TEST (DT/OT I)
112.13.1	TEST SITE ACTIVATION
112.13.2	DEVELOP TEST & EVAL (DT&E)
112.13.3	OPRTNL TEST & EVAL (OT&E)

112.14	TRAINING
112.15	FACILITIES
112.15.1	RDTE
112.15.2	MILCON
112.16	SOFTWARE CENTER
112.16.1	RDTE
112.16.2	MILCON
112.16.3	PROC
112.17	OTHER
112.17.1	RDTE
112.17.2	O&M
112.17.3	OTHER PROC
112.17.4	PROC
120	FULL SCALE DEVELOPMENT
121	CONTRACTOR
121.11	PRIME MISSION EQUIP (PME)
112.11.1	INTEGRATION AND ASSEMBLY
112.11.2	SENSORS
112.11.3	COMMUNICATIONS
112.11.4	AUTO DATA PROCESSING EQUIP
121.11.5	COMPUTER PROGRAMS
121.11.6	DATA DISPLAYS
121.11.7	AUXILIARY EQUIP
121.11.8	COMMON SUPPORT EQUIP
121.11.10	OTHER EQUIP
121.12	SYSTEM PROJECT MANAGEMENT
121.12.1	SYSTEM ENGINEERING
121.12.2	PROJECT MANAGEMENT
121.13	SYSTEM TEST & EVALUATION
121.13.1	MOCKUPS
121.13.2	TEST & EVALUATION SUPPORT
121.13.2	TEST FACILITIES
121.14	TRAINING
121.14.1	EQUIP
121.14.2	SERVICES
121.14.3	FACILITIES
121.14.3.1	RDTE
121.14.3.2	MILCON
121.15	DATA
121.15.1	TECH ORDERS & MANUALS
121.15.2	ENGINEERING DATA
121.15.3	MANAGEMENT DATA
121.15.4	LOG SUPPORT
121.15.5	SOFTWARE SUPPORT DATA
121.16	INDUSTRIAL FACILITIES
121.16.1	RDTE
121.16.2	MILCON
121.16.3	PROC
121.17	SOFTWARE CENTER
121.17.1	RDTE
121.17.2	MILCON
121.17.3	PROC
121.18	OTHER
121.18.1	RDTE
121.18.2	O&M
121.18.3	OTHER PROC

121.18.4	PROC
122	GOVERNMENT
122.11	GOVT FURN EQUIP
122.11.1	INTEGRATION AND ASSEMBLY
122.11.2	SENSORS
122.11.3	COMMUNICATIONS
122.11.4	AUTO DATA PROCESSING EQUIP
122.11.5	COMPUTER PROGRAMS
122.11.6	DATA DISPLAYS
122.11.7	AUXILIARY EQUIP
122.11.8	COMMON SUPPORT EQUIP
122.11.9	PECULIAR SUPPORT EQUIP
122.11.10	OTHER EQUIP
122.12	PROGRAM MNGMNT
122.12.1	PROGRAM MANAGEMENT MILITARY
122.12.2	PROGRAM MANAGEMENT CIVILIAN
122.12.3	PGM MGT CONTRACTOR SUPPORT
122.13	GOVERNMENT TEST (DT/OT II)
122.13.1	TEST SITE ACTIVATION
122.13.2	DEVELOP TEST & EVAL (DT&E)
122.13.3	OPRTNL TEST & EVAL (OT&E)
122.13.3.1	RDTE
122.13.3.2	O&M
122.13.3.3	PROC
122.14	TRAINING
122.15	FACILITIES
122.15.1	RDTE
122.15.2	MILCON
122.16	SOFTWARE CENTER
122.16.1	RDTE
122.16.2	MILCON
122.16.3	PROC
122.17	OTHER
122.17.1	RDTE
122.17.2	O&M
122.17.3	OTHER PROC
122.17.4	PROC
200	PRODUCTION
210	PRODUCTION (NON-RECURRING)
211	CONTRACTOR
211.11	PRIME MISSION GROUP
211.11.1	INTEGRATION AND ASSEMBLY
211.11.2	SENSORS
211.11.3	COMMUNICATIONS
211.11.4	AUTO DATA PROCESSING EQUIP
211.11.5	COMPUTER PROGRAMS
211.11.6	DATA DISPLAYS
211.11.7	AUXILIARY EQUIPMENT
211.11.8	COMMON SUPPORT EQUIP
211.11.9	PECULIAR SUPPORT EQUIP
211.11.10	OTHER EQUIP
211.12	SYSTEM/PROJECT MNGMNT
211.12.1	SYSTEM ENGINEERING
211.12.2	PROJECT MANAGEMENT
211.13	TRAINING
211.13.1	EQUIPMENT

211.13.2	SERVICES
211.13.3	FACILITIES
211.13.3.1	PROC
211.13.3.2	MILCON
211.14	PRODUCTION STARTUP
211.14.1	TOOLING
211.14.2	PRODUCTION ENGINEERING
211.14.3	FACILITIES
211.14.3.1	PROC
211.14.3.2	MILCON
211.15	DATA
211.15.1	TECH ORDERS & MANUALS
211.15.2	ENGINEERING
211.15.3	MANAGEMENT
211.15.4	LOG SUPPORT
211.15.5	SOFTWARE SUPPORT
211.16	INITIAL SPARES & REPAIR PARTS
211.17	SYSTEM TEST & EVAL SUPT
211.18	SOFTWARE CENTER
211.19	CONTRACTOR TECH SUPPORT
211.20	OTHER
211.20.1	PROC
211.20.2	RDT&E
211.20.3	O&M
212	GOVERNMENT
212.11	GOVT FURN EQUIP
212.11.1	INTEGRATION & ASSEMBLY
212.11.2	SENSORS
212.11.3	COMMUNICATIONS
212.11.4	AUTO DATA PROCESSING EQUIP
212.11.5	COMPUTER PROGRAMS
212.11.6	DATA DISPLAYS
212.11.7	AUXILIARY EQUIPMENT
212.11.8	COMMON SUPPORT EQUIP
212.11.9	PECULIAR SUPPORT EQUIP
212.11.10	OTHER EQUIP
212.12	INITIAL TRAINING
212.12.1	EQUIPMENT
212.12.2	SERVICES
212.12.3	FACILITIES
212.12.3.1	MILCON
212.12.3.2	O&M
212.12.4	STUDENT COSTS
212.13	SYSTEM TEST & EVALUATION
212.13.1	PROD ACCPT TEST & EVAL (OT&E)
212.13.1.1	PROC
212.13.1.2	OTHER PROC
212.13.1.3	MILPER
212.13.2	OPRTNL TEST & EVAL (OT&E)
212.13.2.1	PROC
212.13.2.2	OTHER PROC
212.13.2.3	MILPER
212.14	TEST SITE ACTIVATION
212.15	TECH ORDERS & MANUALS
212.16	SOFTWARE CENTER
212.17	INVENTORY MANAGEMENT

212.18	INDUSTRIAL FACILITIES
212.18.1	CONST/CONVERT/EXPAND
212.18.1.1	PROC
212.18.1.2	MILCON
212.18.2	EQUIP ACQUIN OR MODERNIZE
212.19	OTHER
212.19.1	PROC
212.19.2	O&M
212.19.3	OTHER PROC
220	PRODUCTION (RECURRING)
221	CONTRACTOR
221.11	PRIME MISSION EQUIP
221.11.1	INTEGRATION AND ASSEMBLY
221.11.2	SENSORS
221.11.3	COMMUNICATIONS
221.11.4	AUTO DATA PROCESSING EQUIP
221.11.5	COMPUTER PROGRAMS
221.11.6	DATA DISPLAYS
221.11.7	AUXILIARY EQUIPMENT
221.11.8	COMMON SUPPORT EQUIP
221.11.9	PECULIAR SUPPORT EQUIP
221.11.10	OTHER EQUIP
221.12	SYSTEMS/PROJECT MNGMNT
221.12.1	SYSTEM ENGINEERING
221.12.2	PROJECT MANAGEMENT
221.13	INITIAL TRAINING
221.14	DATA DISPOSITORY (PROD)
221.15	MAINTENANCE INDUSTRIAL FCLTYS
221.16	ENGINEERING CHANGES
221.17	DATA
221.18	INITIAL SPARES/REPAIR PARTS
221.19	SYSTEM TEST & EVAL SUPPORT
221.20	TRANSPORTATION
221.21	OTHER
221.21.1	PROC
221.21.2	O&M
221.21.3	OTHER PROC
222	GOVERNMENT
222.11	GOVT FURN EQUIP
222.11.1	INTEGRATION & ASSEMBLY
222.11.2	SENSORS
222.11.3	COMMUNICATIONS
222.11.4	AUTO DATA PROCESSING EQUIP
222.11.5	COMPUTER PROGRAMS
222.11.6	DATA DISPLAYS
222.11.7	AUXILIARY EQUIPMENT
222.11.8	COMMON SUPPORT EQUIP
222.11.9	PECULIAR SUPPORT EQUIP
222.11.10	OTHER EQUIP
222.12	PROGRAM MANAGEMENT
222.12.1	PROGRAM MANAGEMENT MILITARY
222.12.2	PROGRAM MANAGEMENT CIVILIAN
222.12.3	PGM MNGMNT CONTRACTOR SUPT
222.13	TRANSPORTATION
222.14	OPERATIONAL/SITE ACTIVATION
222.14.1	PROC

222.14.2	MILCON
222.14.3	MILPER
222.14.4	O&M
222.15	QUALITY CONTROL & INSPECT
222.15.1	PROC
222.15.2	O&M
222.15.3	MILPER
222.16	SUPPORT ENGINEERING
222.17	INITIAL TRAINING
222.17.1	NEW EQUIP TRAIN TEAMS
222.17.1.1	MILPER
222.17.1.2	O&M
222.17.2	INITIAL OPER TRAINING
222.18	SYSTEM TEST & EVAL
222.18.1	PROC
222.18.2	O&M
222.18.3	MILPER
222.19	INITIAL SPARES & REPAIR PARTS
222.20	OTHER
222.20.1	PROC
222.20.2	O&M
222.20.3	OTHER PROC
300	OPERATIONS AND SUPPORT
310	OPERATIONS
311	OPERATOR PERSONNEL
311.1	CREW
311.1.1	MILITARY CREW
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PERM CHANGE OF STATION
	RETIREMENT
	TRANS. PRIS. PATIENTS
	BASE OPERATING SUPT
311.1.2	CIVILIAN CREW P&A
311.2	INDIRECT PERSONNEL
311.2.1	MILITARY INDIRECT
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PERM CHANGE OF STATION
	RETIREMENT
	TRANS PRIS PATIENTS
	BASE OPERATING SUPT
311.2.2	CIVILIAN IND P&A
312	MATERIAL CONSUMPTION
312.1	OIL, LUBRICANTS (LESS FUEL)
312.2	AMMUNITION, MISSILES
312.3	OTHER MATERIAL
312.4	MATERIAL TRANSPORTATION
313	ENERGY CONSUMPTION
313.1	FUEL
313.2	ELECTRIC POWER
313.3	BATTERIES
313.4	TRANSPORTATION
314	OPERATIONAL FACILITIES

315	EQUIPMENT LEASEHOLDS
316	OPERATIONAL TRANSPORTATION
317	OTHER OPERATIONS COSTS
	PROC
	O&M
	O PROC
	MIL PER
320	MAINTENANCE
321	ORGANIZATIONAL MAINTENANCE
321.1	PERSONNEL
321.1.1	MILITARY MAINT PERS
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PERM CHANGE OF STATION
	RETIREMENT
	TRANS, PRIS, PATIENTS
	BASE OPERATING SUPT
321.1.2	CIVILIAN MAINT PERS P&A
321.2	MAINT MATERIAL
321.2.1	DISCARDED SPARES
321.2.2	REPAIR MATERIAL
321.3	TRANSPORTATION
321.4	ORG MAINT FACILITIES
322	INTERMEDIATE MAINTENANCE
322.1	INTER MAINT PERSONNEL
322.1.1	MILITARY MAINT PERS
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PERM CHANGE OF STATION
	RETIREMENT
	TRANS, PRIS, PATIENTS
	BASE OPERATING SUPT
322.1.2	CIVILIAN MAINT PERS P&A
322.2	MAINT MATERIAL
322.2.1	DISCARDED SPARES
322.2.2	REPAIR MATERIAL
322.3	TRANSPORTATION
322.4	INTER MAINT FACILITIES
323	DEPOT REPAIR
323.1	LABOR
323.2	MATERIAL
323.3	TRANSPORTATION
324	DEPOT OVERHAUL
324.1	LABOR
324.2	MATERIAL CHARGES
324.3	TRANSPORTATION
325	OPER SOFTWARE SUPPORT
325.1	SOFTWARE MAINT PERSONNEL
325.1.1	MILITARY S/W PERS
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PER CHANGE OF STATION
	RETIREMENT

	TRANS, PRIS, PATIENTS
	BASE OPERATING SUPT
325.1.2	CIVILIAN S/W PERS P&A
325.2	SOFTWARE CENTER
325.3	CONTRACT S/W MAINTENANCE
326	MAINT SOFTWARE SUPPORT
326.1	SOFTWARE MAINT PERSONNEL
326.1.1	MILITARY S/W PERS
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PERM CHANGE OF STATION
	RETIREMENT
	TRANS, PRIS, PATIENTS
	BASE OPERATING SUPT
326.1.2	CIVILIAN S/W PERS P&A
326.2	SOFTWARE CENTER
326.3	CONTRACT S/W MAINTENANCE
327	CONTRACT MAINTENANCE
330	MODIFICATIONS
340	SUPPLY SUPPORT
341	SUPPLY PERSONNEL
341.1	ORGANIZATIONAL SUPPLY
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PERM CHANGE OF STATION
	RETIREMENT
	TRANS, PRIS, PATIENTS
	BASE OPERATING SUPT
341.2	INTERMEDIATE SUPPLY
	BASE PAY AND ALLOWANCES
	REPLACEMENT TRAINING
	HEALTH CARE
	PERM CHANGE OF STATION
	RETIREMENT
	TRANS, PRIS, PATIENTS
	BASE OPERATING SUPT
341.3	FIELD DEPOT
342	SUPPLY FACILITIES
342.1	ORG SUPPLY
342.2	INTER SUPPLY
342.3	FIELD DEPOT
342.4	BONDED STORAGE
343	INVENTORY ADMINISTRATION
343.1	INVENTORY MANAGEMENT
343.2	INVENTORY DIST/HOLDING
350	TECH DATA REVISIONS
360	OTHER LOGISTIC SUPT COSTS
	PROC
	O&M
	O PROC
	MIL PER

DISTRIBUTION LIST

Agency	No. of copies
Defense Technical Information Center Cameron Station Alexandria, VA 22314	2
Mr. James Weathersby Code 524 Naval Air System Command Washington, D. C. 20361	1
Mr. Tom Gilbrite Code 524A Naval Air System Command Washington, D. C. 20361	10
Mr. John C. Bemis Major Systems Acquisition Office of Under Secretary of Defense (Research & Engineering) 2A330 Pentagon Washington, D. C. 20301	1
Mr. William Williams Army Procurement Research Office Ft. Lee, VA 23801	1
COL Ron Deep Air Force Business Research Management Center Wright-Patterson AFB, OH 45433	1
Dudley Knox Library, Code 0142 Naval Postgraduate School Monterey, CA 93943	2
Office of Research Administration Code 012 Naval Postgraduate School Monterey, CA 93943	1
Professor Dan C. Boger Department of Administrative Sciences Naval Postgraduate School Monterey, CA 93943	10
Professor Shu S. Liao Department of Administrative Sciences Naval Postgraduate School Monterey, CA 93943	10